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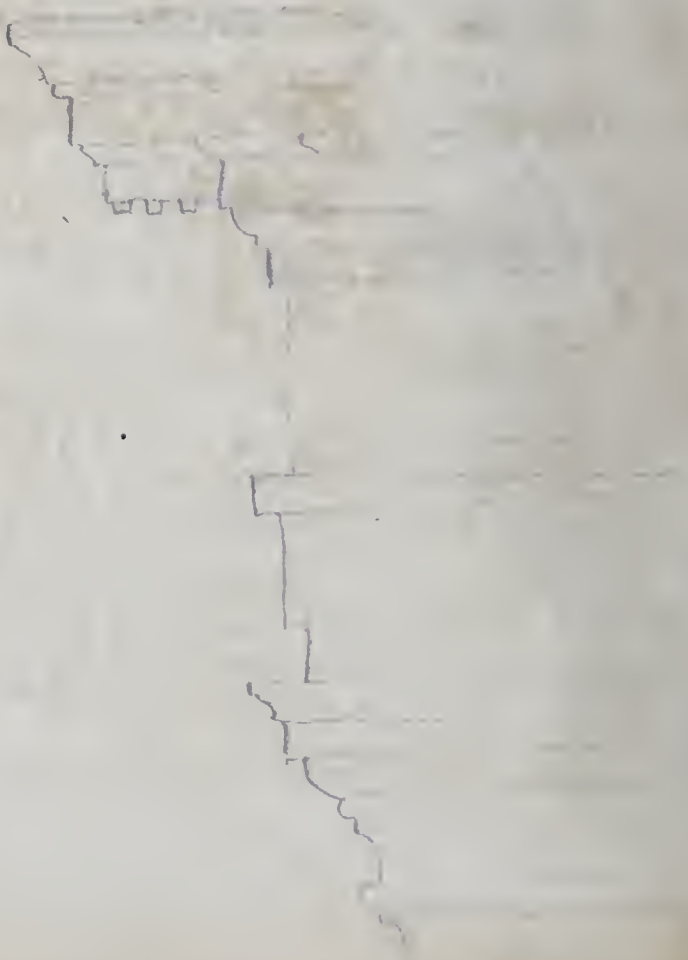
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A

TREATISE

ON THE

SCIENCE OF WAR

AND

FORTIFICATION:

COMPOSED FOR THE USE OF THE

IMPERIAL POLYTECHNICK SCHOOL, AND MILITARY SCHOOLS;

AND

TRANSLATED FOR THE WAR DEPARTMENT,

FOR THE USE OF THE

MILITARY ACADEMY OF THE UNITED STATES:

TO WHICH IS ADDED A

SUMMARY OF THE PRINCIPLES AND MAXIMS

OF

GRAND TACTICS AND OPERATIONS.

BY JOHN MICHAEL O'CONNOR,

CAPTAIN OF ARTILLERY, AND LATE MAJOR AND ASSISTANT ADJUTANT-GENERAL IN THE NORTHERN ARMY.

"Without the rivalship of Nations, and *the practice of war*, civil society "itself could scarcely have found an object or a form."

Ferguson on Civil Society.

IN TWO VOLUMES,

With a Volume of Plates and Maps.

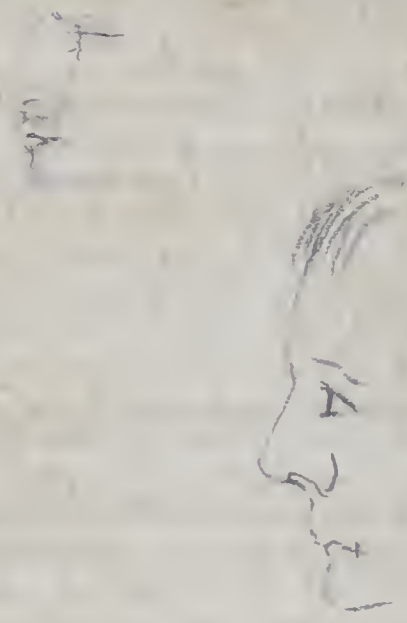
VOL. I.

NEW-YORK:

PRINTED BY J. SEYMOUR, NO. 49 JOHN-STREET.

1817.

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Southern District of New-York, ss.

BE it remembered, That on the twentieth day of August, in the forty-second year of the Independence of the United States of America, John Michael O'Connor, of the said district, hath deposited in this office the title of a book, the right whereof he claims as proprietor, in the words following, to wit:

"A Treatise on the Science of War and Fortification: composed for the use of the Imperial Polytechnick School, and Military Schools; and translated for the War Department, for the use of the Military Academy of the United States: to which is added a Summary of the Principles and Maxims of Grand Tactics and Operations. By John Michael O'Connor, Captain of Artillery, and late Major and Assistant Adjutant General in the Northern Army. 'Without the rivalship of Nations, and *the practice of war*, civil society itself could scarcely have found an object or a form.'—*Ferguson on Civil Society*. In two volumes, with a volume of Plates and Maps. Vol. I."

In conformity to the act of the Congress of the United States, entitled "An act for the encouragement of learning, by securing the copies of maps, charts, and books, to the authors and proprietors of such copies during the times therein mentioned." And also to an act entitled "An act supplementary to an act entitled 'An act for the encouragement of learning, by securing the copies of maps, charts, and books, to the authors and proprietors of such copies during the times therein mentioned,' and extending the benefits thereof to the arts of designing, engraving, and etching historical and other prints."

ROBERT FINN,
Clerk of the Southern District of New-York.

TO

JAMES MONROE,

PRESIDENT

OF

THE UNITED STATES OF AMERICA.

SIR,

If it be true that the invention of fire arms, and the perfection to which war has attained, have greatly contributed to polish and civilize mankind; and that the improvements of modern war form the most impregnable rampart of civil society against barbarism and violence; it must be equally true, that the means which have effected this revolution in the foundations of society, deserve the admiration and study of every enlightened and noble mind.

In the perfection of war, even the Philanthropist and the Patriot find causes of gratulation; for in proportion as it is improved, its ravages are mitigated. And there is reason to hope that when its principles are better understood, the State of War, though as necessary in the political, as tempests in the natural world, will occur less frequently, and will be accompanied by diminished slaughter. A just respect for each other's skill and courage, will often induce nations to decline a severe and an unproductive contest; and the history of mankind will cease to be filled with petty and indecisive wars.

The profession of arms has afforded the busiest and grandest scenes of human virtues and talents, and has ever been considered as the foundation of national virtue and occupation. It is believed that this profession is the great chain that binds together the several Families of the Human Race; and that its extinction would destroy for ever the bonds of Civil Society. War has been always ranked as

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the highest destiny of man; and its successful practice, was the mighty source of the poetry, religion, and enthusiasm of the ancient world. The victorious General became a god among the idols of his country, and altars were raised to those who had defended and civilized their fellow men.

The warnings of our own and other times, admonish us that the strongest pillar of national strength and union, is national glory! and that the most devoted patriotism, and the most inflexible public spirit, are quickened into life by the triumphs of our country and the achievements of her heroes. The name that can never die, was acquired by the Father of his Country in defending the liberties of a Republic that is destined to break the fetters of mankind.

In the present state of the world, a competent knowledge of military affairs, is what every American should possess—for on the example and safety of America, rest the hopes and happiness of mankind. Our country is a beacon to an oppressed and benighted world, and is the foundation of the best reasonings and fondest hopes of the philosopher and patriot. After an imprisonment of ages, the human mind is bursting from its prison house; and a revolution is about to be accomplished in the structure of civil society, by the silent, but irresistible progress of knowledge and opinion.

To facilitate the study of war, the following translation has been composed, and is most respectfully DEDICATED to the PRESIDENT OF THE UNITED STATES, THE MOST ILLUSTRIOUS CITIZEN OF A FREE COUNTRY.

That You may long live to witness the Fame and Prosperity of the nation, of whose Power and Majesty you are the Depositary, is the ardent wish of

Your most obedient and
most respectful servant,
JOHN M. O'CONNOR.

New-York, August, 1817.

INTRODUCTION.

The following translation is presented to the army and public, with a hope that its defects and blemishes will be forgotten in the motive that induced the translator to undertake it—the destitute state of our country in military works, and the impossibility of supplying ourselves from England with works of merit.

The original of this work was composed in 1805 by Colonel De Vernon, Professor of Fortification in the Polytechnick School, by order of the French government; and after being submitted to the revision of a Board of distinguished Marshals and Engineers, was by order of the Emperor Napoleon, adopted as the text and class book of the Polytechnick and Military Schools.

A work of such an origin, and with such sanction and authority, requires no recommendation. Its best eulogium is the use that was made of it under a government whose military institutions have transcended all former efforts of human power and genius. It contains an epitome of all that is known in war; and as it was not written to support any particular and favourite system, it is believed to contain the essence of all military truths, divested of the circumlocutions of writers and separated from the errors of theorists.

The principles that it inculcates, are derived from writers of the highest authority, and from the conclusions of reason and science; and reference is constantly made to those works in which each subject is treated with more minute detail and expansion. The reader is therefore at the same time presented with a catalogue of standard works, and is saved the trouble of wading through all the rubbish that for ages has been accumulating upon this subject.

It appeared to the translator to want a general essay, or summary of the principles and maxims of grand tactics and operations; because the works on these and other branches of war, are locked up in the French and German languages, which few foreigners understand. He has therefore added this desideratum at the end of the SECOND VOLUME; for no person can properly understand grand operations, without a previous knowledge of fortification, which by its truths and reasonings prepares the mind for their reception and comprehension.

This appendix contains the bests principles and maxims of celebrated writers, such as Guibert, Lloyd, Tempelhoff, and Jomini; particularly of the latter, whose work is considered a master-piece, and as the highest authority. Indeed no man should pretend to be capable of commanding any considerable body of troops, unless he have studied and meditated on

the principles laid down by Jomini. It however by no means follows, that the man who understands the theory of modern war, can put it in practice; though without the theory, the practice must be bad. Nor does the knowledge of French prove that an engineer is acquainted with the writers in that language; though it may be safely affirmed, that no man can be an engineer without possessing the means of studying them—a thorough knowledge of the written language.

This translation was originally undertaken with the sanction and approbation of that distinguished statesman—the Honourable WILLIAM H. CRAWFORD, then Secretary of War. A long residence abroad, and a perfect acquaintance with the organization and policy of the monarchies of Europe, had convinced this gentleman of the importance of military discipline and science, and of our want of translations of standard works; and during his administration of the War Department, he did much for the army, and more for the country. By his retirement from the War, to the Treasury Department, the army lost an able and a vigorous head.

As the standard weights and measures of France are founded upon a scale that must sooner or later be universally adopted by all polished nations, these measures have been retained in the translation; and the equivalent English measures have been added in parentheses. A table is given in page 22 (vol. I.), exhibiting the scale of French measures; and by which the reader will be able to correct any trifling inaccuracy that may have occurred in turning those measures into English.

A summary view of the war and peace establishments of the United States, has been also added; and it is hoped that the notes will be found advantageous to the illustration and application of the principles in the text, and that they will help to stimulate the ambition and industry of the cadets of the Military Academy.

The original French technical words have been retained in parentheses, to aid the reader in consulting French works; for very few of these words are to be found in even the best lexicons.

It is a gratification to publicly acknowledge the friendly aid that I have received in the revision of the mathematical calculations of this work, and particularly of those in the VIIth chapter (vol. I.), from the learned and scientific Colonel JARED MANSFIELD, who fills with honour to himself and advantage to his country the Professorship of Natural and Experimental Philosophy at the Military Academy.

And I seize this occasion to make my acknowledgments to Colonel WILLIAM MCREE, of the engineers, for his friendly and attentive examination of the chapter on defilement. It is with good reason that the government, the army, and the country look upon this great soldier and consummate engineer, as their best hope and proudest expectation.

The diffusion of military knowledge in the present era of human af-

fairs, is of great importance. We live in an age that is the most eventful of the world; and although hope has been disappointed, yet there is no reason to despair. The march of the human mind is steady and progressive; and like the motions of the heavenly bodies, is guided by a Hand divine. The revolutions that we have witnessed, are but the precursors of happier events; and it is to be hoped that War, which has ever kept pace with civilization, and become scientific in proportion as the arts and comforts of man have increased, may be the means in its improved state of liberating that world which barbarous violence enslaved.

The military institutions of the United States are small—they should therefore be the more perfect. The importance of each individual increases as the circle narrows; and the country expects more from the talents and devotion of each officer, in proportion as her officers are few. In colossal armies, there will be ability enough in numbers to correct the errors of many; but in small armies, the ignorance of one inferior member may be fatal to all.

As it is only by means of a standing army that the civilization and independence of any country can be perpetuated or preserved*; and as the habits of discipline and subordination are of more importance in modern war, than strength and dexterity were among the ancients; there occurs a constant and imperious necessity of rigorous discipline. "In "every free state there is a perpetual necessity to distinguish the max- "ims of martial law from those of the civil; and he who has not learn- "ed to give an implicit obedience where the state has given him a mi- "litary leader, and to resign his personal freedom in the field from the "same magnanimity with which he maintains it in the political delibe- "rations of his country, has yet to learn the most important lesson of "civil society, and is only fit to occupy a place in a rude, or in a cor- "rupted state, where the principles of mutiny and of servility being "joined, the one or the other is frequently adopted in the wrong "place†."

The army of a free country should be a Sacred Band, ready at any moment to sacrifice their interests and lives to the public weal. Its officers should be superior to the allurements of indolence and pleasure; and they should ever remember, that the political existence of their country depends upon their individual intelligence and skill.

It is found by experience that one of the great means of preventing relaxation of discipline, is to keep the troops together in large bodies upon frontiers, and to often change their stations. "Small bodies of "soldiers quartered in trading or manufacturing towns, and seldom re- "moved from those quarters, become themselves tradesmen, artificers, "and manufacturers. The civil soon predominates over the military "character; and a standing army becomes corrupted‡."

* Smith's Wealth of Nations, vol. 2, p. 166.
† Ferguson on Civil Society, part III sect. 5.
‡ The Wealth of Nations, vol. 2, p. 164.

The force of regulars that modern nations can support, is very small compared to the body of citizens. It is proved that the proportion cannot exceed one soldier to 100 citizens without endangering the ruin of the state*. Their efficiency appears to be in proportion to their expense.

The necessity and superiority of a standing army, are acknowledged by all writers whose opinions are entitled to have weight in the regulation of human affairs. But when a standing army degenerates and bursts asunder the sinews of discipline, instead of a security against, it becomes a lure to foreign violence. The language of party or of faction, has often exalted militia over regulars; and from the same motives has preferred the extravagance of youth to the wisdom of age. Let us listen to the most awful admonitions of history—"The fall of the Greek "republics and of the Persian empire, was the effect of the irresistible "superiority which a standing army has over every sort of militia. It "is the first great revolution in the affairs of mankind of which history "has preserved any distinct or circumstantial account.

"The fall of Carthage, and the consequent elevation of Rome, is the "second. All the varieties in the fortunes of those two famous repub-"lics, may very well be accounted for from the same cause.

"The fall of the Western Empire is the third great revolution in the "affairs of mankind of which ancient history has preserved any distinct "or circumstantial account. It was brought about by the irresistible "superiority which the militia of a barbarous, has over that of a ci-"vilized nation; which the militia of a nation of shepherds, has over "that of a nation of husbandmen, manufacturers, and artificers. The "victories which have been gained by militias, have generally been not "over standing armies, but over other militias in exercise and discipline "inferior to themselves. Such were the victories which the Greek "militia gained over that of the Persian empire; and such too were "those which in latter times the Swiss militia gained over that of the "Austrians and Burgundians."

* Montesquieu, and Dr. Adam Smith

A

TREATISE

ON THE

SCIENCE OF WAR AND FORTIFICATION.

PART I.

ON THE SCIENCE OF WAR IN GENERAL.

CHAPTER I.

Military knowledge; the coup d'œil; *the state of War; an Army in general; Arms, material and mechanical, &c.*

1. THE characteristics of a soldier are, the love of country, subordination, confidence in superiors, fortitude, temperance, and a strong and robust constitution. 1. Qualifications requisite for a soldier, &c.

The officer of the line should be distinguished by a cool and reflecting valour, by a morality of life proving him worthy of command, by contempt of riches and thirst for fame; he should be skilled in arithmetic, elementary and practical geometry, drawing, and field fortification.

The officers of artillery and engineers should possess all the qualifications of officers in the line, and also by knowledge and skill in the arts and sciences, in all kinds of drawing, and talent of the *coup d'œil*, which depends on their science, co-operate in the most important operations of peace or war, and constitute an inestimable corps from which the sagacity of Generals may draw all the resources productive of victory.

The general officers should possess in an eminent degree, the qualifications and talents of officers of all arms of the line, and to a certain extent, those also of artillerists and engineers; but they should chiefly excel in the *coup d'œil*, in its most extended acceptation. This is the grand talent of governing men, and of reaping the greatest advantages amidst any circumstances.

2. When we pass from preliminary acquirements to the proper materials of military science, we distinguish the materials of the art from all that has relation to the *coup d'œil*. 2. The branches of military science; the material; and *coup d'œil*.

The materials comprehend the constitution of troops, their armament, manœuvres, &c. the composition of armies, military topography, the organization of frontiers, encampments, &c. and in fine all that relates to artillery and fortification. These various branches are susceptible of developement and illustration, by mathematics, physics*, and drawing; and they constitute a theory that is within the attainment of all young officers who apply themselves to its study.

The *coup d'œil* is the fruit of genius, of that union and assemblage of talents which discovers instantly the relations of things, and promptly applies to the particular case or occurrence of the moment, the general and theoretical precepts of science. All that relates to this, is the sublime of war. It includes the projection of plans of campaign, the composition of an army to operate on a particular frontier, the conduct of wars offensive or defensive, the choice of camps and positions, the rapid investment of a fortress intended to be besieged, marches to attack the enemy, and formations of general orders of battle, marches in retreat before a powerful and enterprising enemy, &c. &c. This rare talent is the gift of nature to favoured mortals, and can only be developed by study and experience. Military reconnoissances, botanical and mineralogical researches, and hunting, teach the knowledge of a country in relation to the movements of armies, and its attack and defence.

He who cannot study nature, and appreciate the advantages and disadvantages of infinite varieties of ground, must never expect to fill with dignity or ability, the important station of a General.

3. The state of war among nations; the means of waging war; the national force, called *army*.

3. The state of war between nations occurs when, for political reasons and national interests, they break the treaties and conventions that united them in peace, and then finding themselves with regard to each other in the state of nature†, they

* The word "physics" is here used for brevity, in preference to natural and experimental philosophy.

† These supposed rights of the *state of nature*, agree well with the policy of a conquering nation. "Among the writers who have attempted to "distinguish in the human character its original qualities, and to point out "the limits between nature and art, some have represented mankind in their "first condition as possessed of mere animal sensibility, without any exer- "cise of the faculties that render them superior to brutes, without any po- "litical union, without any means of explaining their sentiments, and even "without possessing any of the apprehensions and passions which the voice

have recourse to force to decide their disputes. This *force*, thus employed by one nation to defend her interests against another, is called an *army*.

Military science requires many means with which to form an army: they consist generally,

1st. In the union of bodies of citizens, suitably armed and disciplined for attack and defence.

2d. In artillery generally; a powerful arm to strengthen an attacking or resisting force.

3d. In artificial obstacles erected on military sites, and which, by modifying them in the relations of attack and defence, vary the powers of the active forces, and powerfully influence the results that an army seeks to obtain.

4th. In the departments for ammunition, provisions, hospitals, forage and convoys.

The consideration of the preceding means, gave birth to the different kinds of *arms* of which an army is composed. These are of *four* kinds:

The diverse *arms* composing an army; their kinds and species.

1st. *The arm of infantry*, divided into light infantry, and infantry of the line or battle: this is the principal arm, the basis of an army.

2d. *The arm of cavalry*, divided into three species; light horse, dragoons, and cavalry of the line or battle, consisting of carabiniers, mounted grenadiers, and cuirassiers.

3d. *The arm of artillery*, which, in relation to troops, is divided into horse and foot artillery.

4th. *The arm of fortification* or engineering, including *the arm of mining*.

4. Each arm has in all ages been organized and equipped according to its nature and the effect that it should produce, whether it acted detached and isolated, or combined in certain relations with other arms.

4. The armament and equipment of each arm.

The power of *every arm* is its *united force* in action against the enemy. This power varies according to its armament, and disposition or *order of battle*.

The power of each arm.

" and the gesture are so well fitted to express. Others have made the *state* " *of nature* to consist in perpetual wars, kindled by competition for domi- " nion and interest, where every individual had a separate quarrel with his " kind, and where the presence of a fellow-creature was the signal of bat- " tle." *Ferguson's Civil Society*, part 1, sect. 1.

TRANSLATOR.

5. Composition of an army.

5. The union of all the kinds and species of arms in one and the same mass or corps, constitutes what is called *an army*. The proportions or relations between each *arm*, and the infantry or *principal arm*, is determined by the nature of the war about to be undertaken, the military topography of the country, and other circumstances unnecessary to be at present recited.

The power of an army.

The *power of an army* is the result or sum of all the powers of its component arms or elements; each element being supposed to operate to the greatest advantage, according to its disposition in the general order of battle.

6. The composition of armies, ancient and modern; and their arms, &c.

6. The armies of all people, ancient or modern, have ever been composed of light and heavy troops. Among the ancients, cavalry was scarcely considered but as light troops; but in modern armies we have the heavy infantry and cavalry, and light infantry and cavalry.

Their armament has ever consisted in missile weapons, wielded or cutting and thrusting weapons, and defensive arms. Among the ancients, the missiles were principally used by the light troops; and the wielded and defensive arms by the heavy, or troops of the line. Among the moderns, missile and naked weapons ("*les armes blanches*,") are wielded by the same hands; and all the foot fight with the two species of weapons. Such an alteration must have necessarily produced great changes in orders of battle.

The missile weapons of the Greeks were darts, javelins, hastas*, arrows, and stones. The missiles of the Romans were the pilum, the hasta of the velites, the gœsum or Gaulish javelin, and stones: those of the Gauls and Germans were arrows, javelins, and stones. The Greek infantry wielded the pike or Macedonian sarissa of divers lengths, and the straight sword; the cavalry were armed with the lance, the short pike, and the crooked sword. The Roman infantry fought with the short straight sword and the hasta triari; their cavalry were armed like the Grecian cavalry. The Gauls used a long straight flexible sword, and made great use of armed chariots. The first ranks among the Germans were armed with long handled pikes; the last ranks, and the cavalry, with lances; the German sword, like the Gaulish, was long, flexible, and straight. The buckler

* A javelin without iron.

and helmet, the form and materials of which often varied, and the cuirass and greaves, were the defensive arms of the Greeks and Romans. The Gauls and Germans fought naked, with only a wicker shield.

The machines used by the ancients in sieges.

In sieges, the ancients made use of machines or engines capable of producing great effects; the *balista* and *catapulta*, the invention of which was suggested by the bow and the sling, were used to throw stones, heavy arrows, and other projectiles. The *polybola* was a very complex machine, to throw at the same time arrows and stones. These machines, and the *battering-ram*, constituted the artillery of armies until the invention of fire arms; and were, together with the moving and battering tower (constructed of heavy timber) the engines employed in the reduction of fortified places.

The arms of the moderns until the invention of gun-powder.

The arms of the nations of the North when they conquered the Gauls, were the javelin, the double edged battle-axe, the straight sword, and buckler; their light troops consisted of a feeble cavalry, armed with javelins and arrows. These nations preserved after their conquests their peculiar weapons and mode of combat; but changes were made in arms long before the invention of gun-powder and fire arms. We will detail these changes when we take a summary view of the military institutions from the epoch of the monarchy, to our own days.

CHAPTER II.

Weapons and Military Institutions, down to the epoch of the invention of gun-powder and fire arms.

7. General view of arms and military institutions, from the establishment of the monarchy to the invention of fire arms.

7. THE ancients formed their armies by a conscription of all the citizens capable of bearing arms. But when the feudal system was established in France, the barons assembled their vassals and led them to battle under the banner of their canton. These troops united, formed the army which the King commanded in person; and no sooner was the war ended, than they returned to their homes.

Towards the sixth century the only force of armies was infantry.

In the early ages of the monarchy, and under the Kings of the first race, the force of the armies consisted almost entirely of infantry; there being very little cavalry. But under Charlemagne and the Kings of the second race, the cavalry greatly

Towards the eighth century, cavalry increases in reputation.

increased in numbers and reputation, and was the service to which all the nobility aspired. In a short time it obtained such an ascendancy as to become the only honourable corps; they equipped themselves in defensive armour, and fought with the lance. This prejudice in favour of cavalry existed for a long period.

Institution of knighthood towards the ninth century (See account of the French militia, by Daniel)

The institution of knighthood gave birth to the most valiant cavalry that ever flourished; the knights, clad in defensive armour and wielding the straight sword and the lance, fought in one close compacted line.

The cross-bow, a missive weapon, introduced towards the twelfth century. (See account of the French militia.)

The use of the *cross-bow* is cotemporary with the celebrated Anna Commena; but it is believed to have been known to the ancients: it was a perfect bow, shooting its arrows with admirable aim and ease. Towards the year 1150, this weapon began to be used by both cavalry and infantry, and soon became of such general use that there was a *grand master of the cross-bows*, as subsequently a *grand master of artillery*

Great changes in the armies in the twelfth century, under Philip Augustus and his successor.

In the reign of Philip Augustus there was a great change in the military forces, which then began to be kept in permanent pay, discipline, and service. The numbers thus maintained, were increased from time to time by Louis the IX. and his successors; and the military power assumed a new form by the obligations of service and modes of combat.

The institution of the free companies, in 1400.

In 1400, Charles VII. raised fifteen *free companies* ("*compagnies d'ordonnance,*") each company of 100 *lances;* and

each lance comprehending *one lancer* or armed horseman, *three archers, one squire*, and *one page*. These fifteen companies, containing each 600 men, made a total and mixed force of cavalry of nine thousand.

The volunteers in the free companies.

Illustrious knights and nobles volunteered in these companies, and often swelled their numbers to twelve hundred men.

Titles of knight and captain.

About this time the use of the baronial banner was abolished, and the title of knight became the reward of brilliant and distinguished actions. The commanders of companies and other corps, were styled *captains*.

The cavalry, the only honourable service.

The cavalry, composed of *gendarmes*, *archers*, and *cross-bows*, was the only service esteemed in those ages of ignorance; notwithstanding that the knights and men at arms had often to dismount in battle.

Alterations in the free companies, from 1400 to 1600.

From Charles VII. (in 1440), to the reigns of Francis I. Henry II. and Henry IV. (in 1600), there were many alterations in the composition of the *lance* and of the *free* companies. There were the heavy armed horsemen or gendarmes, the light armed archers, the squires or pages, and the volunteers, the light cavalry cross-bow-men, and the estradiot horse. These latter were very light troops, and were called in France the Albaneese cavalry, because originally Greeks whom Louis XII. brought into the kingdom. The estradiots were armed with broad swords, maces, and the arzegi or pike 40 decimètres ($13\frac{1}{2}$ feet) long, which they used with great dexterity on foot or on horseback.

The light estradiot horse.

The French infantry from the year 1400 to 1600.

Although in the reign of Charles VII. (1440) cavalry constituted the force of armies, yet great pains were taken to perfect the infantry: independent archers were raised, selected, and disciplined by the communes, and on the first notice marched to the armies, commanded by captains and captains general.

Captains and captains general.

In 1470 Louis XI. perfected these troops, of whom he raised sixteen thousand, commanded by four captains general, having each seven captains under them.

Infantry regularly maintained and paid in 1480

The independent archers were abolished by Louis XII. and replaced by regularly paid and maintained infantry, commanded by the most illustrious knights, such as the chevaliers Bayard, Molard, &c. who in the Italian wars relinquished the lance for the pike, and accustomed to battle this new species of infantry.

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Institution of the legion by Francis I. in 1534.

That consummate soldier Francis I. in imitation of the Romans, divided his infantry into seven legions of six thousand men, each commanded by six captains, one of whom was colonel commandant. Every captain had under him two lieutenants, two ensigns and sixty centurions. The whole formed a total force of forty-two thousand infantry. It was at this period that the office of colonel-general of infantry was created.

Office of colonel-general of infantry.

Weapons of attack and defence at the invention of gun-powder.

Towards the fifteenth century and before the use of fire arms, the weapons of offence were,

1st. For cavalry; the lance, the straight sword, the dagger, the bow and arrow, the cross-bow, the mace, and the arzegi:

2d. For infantry; the straight sword, the spear or pike staff, the battle-axe, and pike; the halberd, the partisan, the bow and arrow, and the cross bow.

The defensive weapons were,

1st. For the cavalry; the helmet or head piece, ("*pot en tete*") the cuiras, the coat of mail, and the coat of arms or tunic that covered the former, and the corselet or light cuiras made of wrought iron, &c.

2d. For infantry; the capellina or iron helmet, the mail jacket fitting close to the body, and the basket shield ("*panier de tremble.*") In the time of Francis I. the foot soldier wore the complete corselet.

8 Reflections on the pike; use of this weapon about 1450

8. The term *pike* is not older than the year 1450, though this long reaching weapon is of the remotest antiquity. Its length was different among different nations: By the Greeks and Macedonians it was called the *sarissa*, and was upwards of 60 decimetres (20 feet) in length. Its greatest length among the moderns did not exceed 45 to 50 decimetres (15 à 16½ feet), and it was successfully used by all the various nations that have been renowned in arms. The Greeks adopted it from the Egyptians, and made it the weapon of the famous phalanx; and the Macedonians wielding the pike, made their way to fame and victory. The Romans made use of different kinds of weapons, and owed their successes to the pilum and short straight sword. After the German nations had overturned the Roman empire, we find this long reaching arm among their cavalry under the denomination of *lance;* and in the use of which they became the terror of infantry. To defend themselves against cavalry, several nations revived the use of the pike; and it

was with this weapon that the Swiss, attacked on all sides by the Austrian horse, repulsed and defeated them; proving by signal victories that it was admirably adapted for a brave and disciplined infantry. In imitation of the Swiss, the Germans, Spaniards, Italians, and French, successively equipped their infantry with the pike; and it continued in use among them to the beginning of the eighteenth century, when it was universally laid aside for the musket and the bayonet.

CHAPTER III.

The invention of Gun-powder and Fire arms, &c.

9. The invention of gun-powder and fire arms.

9. THE invention of gun-powder and fire arms forms one of the most distinguished eras, and obtained a great and decided influence over military institutions, weapons, and orders of battle. The gradual introduction of fire arms into armies, produced modifications in their formation, and novel principles and maxims in tactics. The analysis of gun-powder and of the substances combined in the fabrication of fire arms, is the province of chemistry applied to the arts: the effects produced by these weapons, depend upon mechanics.

About the year 1256*, and during the crusades of Louis IX, Roger Bacon discovered the principles of gun-powder. In 1300, Anebren, a monk of Fryburg, demonstrated by experiments the powers of ignited gun-powder, which naturally gave birth to the invention of fire arms.

The first fire arms called cannon or bombards, and their use in 1330.

The first fire arms were constructed about the year 1330, under Philip de Valois, and were called *cannon* or *bombards*. This is the earliest period to which the use of artillery is ascribed. The first efforts of metallurgy produced only pieces defective both in construction and fabrication. It was necessary in the infancy of the art to familiarize the mind with its effects on a small scale; and history informs us that from 1330 to about 1450, cannon, bombards and culverins, were so light as to be manœuvred by hand. Under Louis XI, they were called hand guns (*cannons de main*). The first fire arms weighed from 20 to 50 pounds, mounted and manœuvred on small moveable carriages. The lightest kind could be used by supporting them on an iron rest stuck in the ground; they were made of copper and of wrought iron, and projected small leaden balls, and were probably very short.

Great quantities of small artillery used in armies about the year 1411.

About 1411, cannons and culverins were very numerous in armies; in sieges the number of cannon and bombards used, often equalled three hundred; and in battles it was common

* Extract from Sir Francis Bacon's Moral and Political Essays. "Ordnance was known in the city of Oxydraces, in India, and was that "which the Macedonians called "*thunder, lightning*, and *magic*;" and it "is well known that the use of ordnance hath been common in China "above two thousand years." TRANSLATOR.

to behold two to four thousand culverins. At the battle of Morat in 1414, the Swiss army had ten thousand of the latter. In these remote ages, this weapon was nothing more than a large matchlock, very unlike the culverins of after times.

Origin of heavy artillery, from about the year 1420 to Henry IV. (1590)

The effects of this small artillery suggested the invention, and was followed by the introduction of heavy cannon and bombards for the defence and attack of towns. Some were made for this purpose in 1420; and we find that a few heavy cannon and bombards were used as early as 1338. In the reign of Charles VI, about the year 1383, balls of freestone were fired from a species of short cannon or mortar. In 1378 Schwartz instructed the Venetians in the use of cannon, and they used them with success against the Genoëse.

Artillery followed the armies, about 1450.

At this period and until about 1450, cannon did not exceed in weight 120 pounds, and were used to fire cast iron and leaden balls. They were moveable, and followed the armies. In the Italian wars of Charles VIII,* the French and Venetian armies had field artillery; and at the battle of Taro (near Parma,) the Venetian batteries were dismounted by the French artillery. In the dreadful retreat of Charles out of Italy, in the same year, at the evacuation of Pontrëmoli, he found great difficulty in transporting his artillery, when 200 Swiss offered to drag his cannon and get them over the mountains. These facts prove that the artillery of those days was light, and kept up with the movements of armies.

Heavy artillery in 1470.

The weight and dimensions of artillery were successively increased, and in the reign of Louis XI (1470) some pieces of a prodigious size were produced, but not made of wrought iron or pure copper. At first the pure cast metal was used; but experience soon led to casting in alloy or brass. 'Tis of this metal that all the land artillery in Europe is at present made.

Its fabrication and projectiles.

In the year 1400, cast iron balls were substituted for balls of stone; and in 1470 there was cast at Tours a cannon of 500 pounds caliber, much resembling our mortars; it is related, that it threw its projectile from the Bastile to Charenton. The cannon of the greatest length in France, was the Culverin

* On Charles marching into Rome in 1494, the Pope Alexander VI. retired to the castle St. Angelo; but no sooner did he perceive the French artillery pointed against its feeble walls, than he capitulated. *Georgi Fluvi, de Bel' Ital.' Phillip de Commines, book 7.* TRANSLATOR.

of Nancy, cast in 1598, and was 22 feet (23 feet 5 inches English) long. It was observed that its range was not greater than pieces of the ordinary length.

Distinction between field and battering artillery since 1350.

During the reigns of Louis XII, and Francis I. the heaviest siege artillery was generally 50 pounders. And since the year 1350 there have been two kinds of artillery, the one for besieging and defending fortresses, the other for the field of battle.

From Louis XI. (1450,) to Henry II. (1550,) trains of artillery were numerous, and this arm began to obtain a preponderating influence in all military operations. But the civil wars that followed, arrested the progress of the arts: and to the reign of Henry IV. (1590,) artillery was neglected and of little effect in battle. At Ivry the army of the league had only four cannon, and the royal army six.

Artillery from the days of Henry IV. (1590,) to our own times.

Sully, having been made grand master of artillery, exerted himself to put this arm on a respectable footing, and to him it owes its first fame, for the improvements he introduced in the material and service of the arm, which thenceforward was regarded as the most powerful weapon in the reduction of places. The Spanish general, count Fuentes, arrayed before Cambrai 70 pieces of all calibers; and towards the middle of the 16th century (1562,) Queen Elizabeth of England introduced into her kingdom the arts of manufacturing gun-powder and founding cannon in copper. Under Louis XIV. (1660,) artillery was enlarged and perfected in all its branches.

Importance of field artillery.

By new means of transportation, pieces of heavy calibers were brought into the field, and their mighty efforts combined with those of infantry and cavalry. The striking influence of artillery in the success of wars, became a fresh subject for military science, which thereby received a new direction in the application of its general principles.

10. The invention and use of *small arms* among the troops, as early as 1520.

10. Successive improvements in fire arms led to the perfecting of the primitive culverins, and making them lighter, and to the invention of real small arms. Arquebuses of various kinds were made, and used for the defence of cities: some were even mounted on stocks with locks to fire them. The use of this last species became common towards the year 1520, during the reign of Louis XII. In firing it was supported on a rest. In the end they were made so light as to be used either on foot or on horseback.

The arquebuse.

The matchlock and pistol, used in 1567.

After the invention of the arquebuse, which was ill suited for the field, the matchlock ("*mousquet*") was introduced, and from the year 1567 was much used in armies. The first were so heavy that a rest was necessary to fire them; but they were gradually made lighter and easily handled. The great or heavy matchlock, was for the defence of towns; and the light matchlock for field service. After the matchlock, appeared pistols with locks, with which the light cavalry began to be armed. From 1570 the use of matchlocks and pistols progressively increased; and towards 1670 a great portion of the infantry were armed with matchlocks fired by cocks. In consequence of the great numbers of matchlock-men in the infantry, the matchlock was also converted into a naked arm ("*arme blanche*,") by adding to it the bayonet, the wooden handle of which was strongly fixed in the muzzle of the piece.

The wooden handled bayonet added to the matchlock, about 1671.

Substitution of the pyroballistic musket for the matchlock.

Experience having shown the inconveniences of using the matchlock, and the serious accidents caused by their lighted matches, the Pyroballistic weapon, called musket ("*fusil*") was invented in 1630, and from 1672 was substituted for the matchlock, and became the only arm of the infantry, and one of the weapons of dragoons.

Substitution of the socket bayonet for the wooden handle, in 1699 and 1700.

In 1699 the socket bayonet was fortunately substituted for that with the wooden handle, and thus the musket and bayonet became at the same time a missive and wielded weapon.

Models of the modern musket.

The muskets first used were not as perfect as those in our days; they were heavier and longer, and had defects that were gradually remedied. They were greatly deficient in uniformity of caliber and dimension.

See the following table.

The corps of artillery, constantly occupied in the perfecting of arms, devoted unceasing attention to this principal arm; and at different periods models were established, and the manufactures obliged to conform thereto. These models were; that of 1746, length 44 inches, (3 feet 11 inches English,) and weight 10 pound 4 ounces (11 pds. English); those of 1754 and 1763, weight 10 pounds (10 pds. 12 oz. English); and that of 1766, weight 9 pounds 8 oz. (10 pds. 4 oz. English). We distinguish also the models of 1768, 1770, 1771, and 1773, weighing 9 pounds 8 oz. (10 pds. 4 oz. English); that of 1774 weighing 10 pounds (10 pds. 12 oz. English); and lastly, that of 1777 weighing 9 pounds 8 oz. (10 pds. 4 oz. English). The model of 1777, corrected in the 8th year (1800), is that which is now conformed to in the national manufactories.

TABLE OF THE DIMENSIONS OF THE MUSKET FOR INFANTRY.

French Measures.*

		In.	Lines.	Points
Diameter of the bore			7	9
do. at the muzzle			10	
do. of the artillery musket			9	6
do. of the vent-field			14	6
do. of the artillery musket			14	
do. of the vent or touch-hole, hardly 1 line			1	
do. of the ball, 18 to the pound, and weighing 7 drams 8 grains			7	
Length of the barrel	of the infantry musket	42	Calibre 7	9
	of the artillery do.	34		
	of the dragoon do.	40		
	of the rifle	24	Ca. 7	7
	of the blunderbuss ("*mousqueton*")	28	do.	
	of the pistol	7	do.	

Total length of the musket and fixed bayonet, 6 feet 2 inches (6 feet 5½ inches English).

French weights.

		Pounds	oz.		Pds.	oz.
Total weight	of the infantry musket	9	4	to	9	12
	of the artillery do.	8	14			
	of the dragoon do.	9	4	to	9	12
	of the rifle					
	of the blunderbuss	6	9	to	6	10
	of the pistol	2	10	to	2	12

Price in the 8th year, (1800).
- of the infantry musket, model of 1777, at St. Etienne 34 francs, and at Leige, Charleville, and Maubeuge, 30 francs.
- of the musqueton or blunderbuss, throughout the empire, 25 francs.
- of pistols, per pair, ditto, 30 francs.

N. B. The franc is valued at 18½ cents.

* *Table of the present system of French Measures, with their value in American Measures.*

Present Measures.	*Subdivisions.*	*Value in American Measures.*
The myriamètre, or new league.	10,000 mètres, or 10 miles.	32,809 feet 2 inches, or 6 miles 1129 feet 2 inches.
The mile, or kilomètre.	1000 mètres.	3280 feet 11 inches, or nearly 3-5ths of a mile.
The perch, or decametre.	10 mètres.	32 feet 9,07 inches.
The mètre.	$\frac{1}{40,000,000}$ part of a meridian of the earth.	39,3702 inches, or about $3\frac{1}{3}$ feet
The palm, or decimètre.	$\frac{1}{10}$ of a mètre, or 10 *doigts*.	Nearly 4 inches
The doigt, or centimètre.	$\frac{1}{100}$ of a mètre, or 10 *traits*, or 10 millimetres.	Nearly $\frac{4}{10}$ of an inch.

Table of values of the ancient Measures of France.

Ancient Measures.	*Value in the new Measures.*	*Value in American Measures.*
The common league.	4444 mètres 44 centim.	5228 yards.
The Paris ell or yard.	1 mètre 188 millimètres.	3 feet 7 inches 8 lines.
The toise.	1 mètre 948 millimètres.	3 feet 6 inches.
The foot.	325 millimètres.	1,068 feet, or $1\frac{1}{14}$ foot.
The inch.	27 millimètres.	1,036299 inches.
The line.	2 millimètres.	,07876 inch.

Other species of small arms:—the blunderbuss, the rifle, and the pistol.

The other species of fire or small arms, are, the musketoon or blunderbuss ("*mousqueton*"), the rifle ("*carabine*"), and the pistol.

The blunderbuss ("*mousqueton*") is a kind of short musket formerly used by the heavy cavalry; the use of it was abolished at the beginning of the last war.

The carabine is cotemporary with the musket; there are several kinds, some for the use of part of the light infantry, and others for the light cavalry. The pistol is one of the ordinary weapons of troopers.

The naked weapons of the moderns: the sword, and bayonet.

The naked or cutting and thrusting weapons of the moderns are, the musket armed with the bayonet, and swords of various kinds. There were formerly about ten kinds of swords; but they are now reduced to three, as respects the manner in which the troops should use them; viz:

1st. The straight sword for the trooper, dragoon, and heavy cavalry, 36 inches long (38½ in. Eng.); its power in attack is in the *point* or thrust.

2d. The sabre or curved sword, for hussars, chasseurs, and horse artillery; length 30 inches (32 in. Eng.); its power in attack is in the *edge* or cut.

3d. The hanger ("*le briquet*"), for all the foot; length 22 inches (23½ inches).

Defensive armour of the moderns.

All the defensive armour used before the discovery of fire arms, has been successively laid aside, except the helmet and cuirass, still used by heavy cavalry and dragoons. Formerly all cavalry of the line wore the demi-cuirass, and the causes of its suppression at the beginning of the last war are unknown, for this sort of armour did not incommode the horseman, and gave him greater confidence in the charge. But as all the cavalry of the line are now composed of cuirassiers, this object is attained. We would however add, that as the dragoons enter into line with cuirassiers, and like them charge with the point, it is desirable that they should use the demi-cuirass, which they could lay aside as they do their horses on dismounting to perform the service of infantry.

The musket-proof cuirass, and "*pot-en-tete*."

The musket-proof cuirass, and the head-piece or "*pôt-en-tête*," are part of the stores in the parks of artillery and engineers; these are worn by the officers and workmen in tracing and executing works under fire of the besieged, and especially when conducting the saps.

In the chapter on modern artillery, we will conclude our remarks on the material of offensive arms.

CHAPTER IV.

Military institutions and weapons since the invention of fire arms; Rank and grades; and the composition and force of the military power of France, &c.

Military institutions and weapons since the use of fire arms, about 1550.

WE are now at that important era when the constitutions and weapons of armies having been entirely changed, war became a *science*, and the confusion and ignorance in which the public forces had languished, was dispelled and enlightened.

11. Suppression of the bow and cross-bow; replaced by matchlock-men, carabiniers, and arquebusiers.

11. Towards 1580 the use of fire arms became so universal that they supplanted the ancient weapons, and produced new species and denominations of troops. Those who carried the matchlock, were called *matchlock-men* ("*mousquetaires*"); the *cross-bow-men* were transformed into *carabiniers* and *arquebusiers*, and another part of the infantry into *pikemen*.

12. Suppression of the lance, and formation of cavalry into companies: distinction between light and heavy cavalry.

12. In the reigns of the IIId and IVth Henrys, towards the year 1560, the lance was abolished, and the cavalry formed into *companies;* each company of gendarmerie or heavy cavalry being headed by two arquebusiers. In 1510, Louis XII, taking for model the estradiot horse in the Venetian service, applied himself to form some companies of light cavalry. This species of cavalry progressively increased, and was distinguished from the gendarmerie or cavalry of the line. Under Francis I. and the IId, IIId, and IVth Henrys, it was further increased and organized into companies of light horse, each company often having in its train 50 carabiniers for skirmishing. In the reign of Louis XIII, the carabiniers or riflemen were formed into a regular corps, and, together with the arquebusiers, gave rise to the dragoons or mounted infantry. From 1550, and under Henry IV, there were dragoons in the armies, and we trace their institution down to about 1624, when they were abolished for a short time. In 1635 they were revived, and have existed ever since with different forms of organization: their formation into regiments took place in 1657.

Carabiniers and dragoons, and "argoulets" or troopers

There was another species of light horse in the armies, called troopers or argoulets; they were a kind of hussar, and harassed the enemy and ravaged his country; their arms were the straight sword and arquebuse.

13. After the bloody battle of St. Quintin, Henry II. felt the necessity of putting the infantry upon a more permanent and respectable footing; he revived the legions of Francis I. In 1557 he raised seven legions or bands ("*bandes*") of 6000 men each; each legion of 15 companies commanded by captains with inferior officers: the legionary chief was styled master of the camp ("*mestre de camp*").

13. Infantry formed into legions by Henry II, 1557.

The legion of Guienne having been reduced in 1562, Charles IX re-established it under the denomination of *regiment*, which appellation became common to all the legions; and since this period the term *regiment* is applied to all corps, whether of cavalry or infantry, divided into companies and commanded by a colonel or "*mestre de camp*." In process of time, the regiments formed out of the original legions, and which were not disbanded at the conclusion of a war, were called the *old bands* or *corps*. The regiments raised after the first legions, and which were in part reduced on the termination of a war, were called the *little* old corps.

They are called regiments by Charles IX, 1567.

The old bands or corps.

The little old corps.

14. When towards the year 1560, the free companies were formed into companies of gendarmerie, the men at arms were clothed in armour, and armed with the straight sword and the lance. The inconveniences of this long-reaching arm for cavalry of the line, were soon perceived, and it was almost universally abandoned. In the time of Henry IV, there were very few lancers; and in the reign of Louis XIII, the use of the lance was entirely abolished. The weapons of the light horse, were the same as those of the heavy cavalry; but their defensive armour was lighter: by degrees the latter was laid aside, the heavy cavalry preserving only the cuirass, the use of which in the infantry was positively prohibited. The offensive arms of the infantry were reduced to the matchlock, the pike, and the straight sword, which soon after gave way to the bayonet.

14 Cavalry and infantry arms and equipments.

These successive changes led to the state of perfection to which military institutions and weapons attained in the brilliant age of Louis XIV.

15. After so many changes, the able generals of Louis XIII (1635) were led by reflection and experience to propose a mode of organization simple in itself, applicable to a prompt formation of the national forces, and of separate armies, and capable of displaying the powers of a *corps d'armée*. This admirable plan was, to organize all the infantry into units of force called

15. Improvements in military institutions under Louis XIII. (1635).

Origin of the battalion and squadron.

battalions; and all the cavalry into units called *squadrons*. The

Definition of battalion. *battalion* is an unit of force of infantry, and is a mass or body of 500 to 1000 foot acting in conjunction and concert for battle

Definition of squadron. or manœuvre. The *squadron* is an unit of force of cavalry, and is a mass or body of 130 to 200 horsemen fighting or acting in conjunction and concert.

16. The institution of carabiniers and grenadiers between 1667 and 1692.

16. The operations of sieges gave birth to the institution of *grenadiers*, who most probably were originally used to throw grenades into the works of the enemy. The first grenadiers were instituted in 1667 in the *ci-devant* King's regiment, in the proportion of four to a company; in 1670 they were all united in one company; and in 1672 and the following years, these select troops were formed in all the regiments in the proportion of one company to every battalion. The companies of grenadiers in the battalions of a *corps d'armée*, are often united together and formed into battalions, to strike a great or decisive blow in a siege or battle.

The institution of grenadiers originated a similar institution in the cavalry, of carabiniers. In 1676, four life-guardmen per brigade were armed with carabines, and in the following year the number was increased to seventeen. In 1679 two carabiniers were attached to every company of cavalry. Marshal Luxembourg having at the battle of Fleurus assembled all the carabiniers in one body, and obtained thereby great advantages, Louis XIV was in consequence induced to increase the number to one company of carabiniers for every regiment of cavalry. Finally, in 1692 all these companies were reunited into one corps of carabiniers, which since that time has not sustained

Weapons of the carabiniers. any important change. The carabiniers carry the weapons of both heavy cavalry and infantry; they are mounted grenadiers, and adapted for great and decisive strokes on foot or on horse-back.

Reflections on the organization of carabiniers. It is a subject of astonishment that the carabiniers should have been united to form one corps at the head of the cavalry; for if like grenadiers they are useful in each corps d'armée, it would seem that each army or corps should be provided with them, as with grenadiers.

17. The constitutions and weapons of armies during the time of Turenne and Conde, in 1678, and subsequently.

17. We will now take a view of the constitutions of troops at the epoch that Turenne and Condè commanded the armies, and astonished Europe by their victories. These *great men* laid the foundations of military science, by leaving to their successors the memorable and numerous results of their admirable combinations and use of the forces that they commanded.

The corps of the king's household.

At this period there were numerous corps, such as the life-guards, the light-horse, the gendarmes of the guard, the matchlockmen, the brigades of men at arms or "*gendarmerie*", and the company of horse grenadiers; these troops formed the household of the king, and often decided the fate of battles. The matchlockmen ("*mousquetaires*") fought either on foot or horseback. At the battles of Neerwinden and Fleurus, they performed prodigies of valour, and carried by assault the citadel of Valenciennes. At the battle of Cassel, after combating sword in hand, they charged the enemy by squadrons. All these corps, with the exception of the life-guards and gendarmerie, were suppressed by the count de St. Germain.

The cavalry.

The cavalry were divided into gendarmerie, dragoons, and light cavalry, formed into regiments of from two to four squadrons. The squadron consisted of three companies of 50 troopers, one quarter-master ("*marèchal des logis*,") one cornet, one captain, and one lieutenant. All the cavalry were armed with the straight sword or sabre, and the pistol; the dragoons carried the musket with the wooden-handled bayonet.

The infantry.

The infantry was divided into French, and foreign infantry; both organized into regiments of from two to four battalions; each battalion of 17 companies (including the grenadier company,) and each company composed of 41 privates, 1 drummer, 8 non-commissioned officers and 3 officers; making together 902 men, including the lieutenant colonel, and of whom 53 were officers.

The officers were armed with pikes 10 feet ($10\frac{3}{4}$ feet Eng.) in length, the sergeants with halberds 7 feet ($7\frac{1}{2}$ feet) long; 4 soldiers were armed with muskets, 12 with pikes, and the rest with matchlocks. The grenadiers used the musket and wooden handled bayonet.

18. The constitutions and weapons of troops in 1703.

18. There were no changes in the cavalry in 1703; but the infantry sustained some slight modifications. The battalions were reduced to 13 companies, including the grenadiers, containing 59 men, of whom 3 were officers; and the strength of these battalions was 690 men, including 40 officers. The officers carried espontoons 8 feet long ($8\frac{1}{2}$ feet Eng.), the sergeants were armed with halberds $6\frac{1}{2}$ feet long (7 feet Eng.), and the soldiers with muskets with the socket bayonet.

19. The formation of military forces in different ages.

19. We will conclude this chapter with a few words upon the modes in which nations have formed their armies. We

have seen (7.) that among the ancients, all the citizens capable of bearing arms were soldiers, and on the first notice assembled together to form the armies. The ancients, therefore, followed the method of a *military conscription*. When the barbarians of the north had subjugated Europe, and established the feudal system, the people who had become slaves, served as such under the banners of a nobility, whom the love of glory and domination had rendered warlike. After the Crusades, and in proportion as the French and other European monarchies strengthened and consolidated, military service became more regular and less arbitrary. The chief magistrate of the state applied for soldiers to the Commons, and left them the liberty of choice. This mode of recruiting obtained in the different states, until the institution of the *militia* and *military conscription*. Towards 1720 the militia was instituted in France and in most other states. It consists in procuring by lot national soldiers to form peace-establishment battalions, which assemble in time of war or commotion, or supply the daily losses and deficiencies of the standing corps, and increase them from the peace to the war establishments. By the conscription all citizens capable of bearing arms, are obliged to serve a given time fixed by law ; and its classes are called to their standards according to the necessities of the state. From 1726 to 1790, France invariably followed the system of militia by lottery, and there were in the kingdom in 1774, 104 provincial battalions, whose grenadier companies formed 11 regiments. In 1778 and following, the militia was organized into 106 provincial battalions, of which 26 were attached to the king's regiment, to the staff of the army, and to the artillery : two battalions, including their grenadiers, formed the regiment of Paris ; and the remaining 78 were called *Garrison Battalions*, and attached to the 78 regiments of infantry, of two battalions, after which they were named. The 104 companies of grenadiers formed 13 regiments of *Royal Grenadiers*, of 8 companies each.

The militia system of France, from 1726 to 1790; garrison battalions, and battalions of royal grenadiers.

Since the French Revolution, the national army has been formed, 1st, by battalions of volunteers ; 2d, by "*requisitions*," 3d, by military conscription. This method of recruiting the armies was that of the ancients, and is consonant with justice and the public interest. It impresses upon the soldiery a civic character, and reminds each member of society of his duty and devotion to his country.

The French militia system since 1790.

Prussia, Switzerland, Holland, and the Republics of Italy, have adopted the conscription with modifications arising from their forms of government. In the German empire, the militia system has been long adopted, and the militia is estimated at 80,000 men. The militia of other European nations.

In England the militia is still formed after the feudal system, and amounts to nearly 200,000 men of infantry and cavalry.

In Spain the body of militia is formed by lottery, and amounts to 40,000 men.

Russia, Denmark, and Sweden, have each peculiar modes of forming their militia. Before 1784, the Russian militia formed regiments for guarding the frontiers ; but they have since been incorporated into regiments for annual service during a short and fixed term.

20. All the military institutions of Europe have now the same basis, viz: 1st, the same kinds and species of *arms* ; 2d, the same mode of armament. All the powers have a permanent and organized militia disciplined for attack and defence, and from which are drawn the constituent elements to form an army destined for a particular campaign. We have before stated (chap. I. 3, 4, 5, & 6.), the different kinds and species of active arms that enter into the composition of the armies of modern nations ; and we repeat, that the infantry is the principal arm, and by which all others are regulated ; and that particular armies are formed by combinations of the different *arms*, according to the proportions and relations indicated by the plan of campaign, &c. 20 Modern military institutions; armies formed by combining together the different arms ; organization of the French army from 1780 to 1804.

Hence it follows, that the organization of the army of any one powerful nation, affords a general insight into the formation of all European armies, regard however being paid to modifications existing in all armies from the national character and government.

21. In all military institutions, ancient and modern, there have been grades and dignities, different among different nations and countries. Formerly there were in France various orders and dignities, the analogous of which still exist among other powers. In considering only the simple formation of troops, we distinguish above the private soldier the following grades ; viz. 1st, the non-commissioned officers, designated in 21. Military rank and grades.

the infantry as *Sergeants* and *Corporals*, and in the cavalry as "*Marechaux des Logis*," and "*Brigadiers**."

2d. Above these are the platoon officers (*officieres ordinaires*), entitled in the infantry, cavalry, artillery and engineers, Captains, Lieutenants, and Sub-Lieutenants.

3d. Next above these are the superior or field officers, styled in the infantry, Majors, Lieutenant-Colonels or Chiefs of Battalions, and Colonels or Chiefs of Brigade; this latter designation is now no longer used: and in the cavalry, Chiefs of Squadrons (*Chefs d'Escadron*), and Colonels or "*Mestres de Camp*."

4th. Above the field or superior officers who command regiments or corps, are the general officers, including Generals of Brigade. Formerly they were called Brigadiers of the army, and Major-Generals, (*Brigadiers des Armeès et Marechaux de Camp*); and the Generals of Division were styled Lieutenant-Generals.

5th. The title of *General in Chief* is given to the General commanding an army, and it ceases with his functions. Lieutenant-Generals are the Generals who, under the General in Chief, command the centre and wings of an army.

6th. The title of Adjutant-Commandant, formerly Adjutant-General, is given to the field officers composing the staff of armies.

The origin of the grades of captain, lieutenant, and sub-lieutenant.

The title of *Captain* has always designated a military commander. In the earliest French military institutions the name of Captain was given to the governors of cities and fortresses, and was then, as now, used to distinguish the more or less eminent qualifications of a warrior destined to conduct military operations. Charles VII (7.) gave this title to the commanders of the free companies; and Louis XI was the first who conferred it upon the chiefs or leaders of the corps of regular infantry. In the legions raised by Francis I, each captain commanded 2000 men; these bands or companies were successively diminished, and under Charles IX were reduced to 50 men. At length in 1635, battalions and squadrons were divided into companies commanded by captains, having under them lieutenants and sub-lieutenants.

* *Marechaux de Logis*, and *Brigadiers* in the French cavalry, are equivalent to our sergeants and corporals. TRANSLATOR.

The grades of colonel and "*mestre de camp.*"

We have seen that from 1567 the grade of "*Mestre de Camp*" was conferred upon (13) the commanders of legions, when these took the name of Regiments or Bands. This title gave place in 1661, in the infantry and dragoons, to that of Colonel, which was specially attached to these corps. And in 1635, when the cavalry was organized into regiments, the commanders of corps of cavalry took the title of "*Mestre de Camp ;*" this title no longer exists.

The grade of brigadier in the armies.

The term *Brigade* is ancient, and was used under Louis XIII (1633) in the Gendarmerie, and subsequently to designate portions of an army. Turenne was the first General who saw and felt the advantages of uniting several regiments under one commander ; and it was upon his recommendation that Louis XIV in 1665 instituted in the cavalry, and the year following, in the infantry, the office and rank of Brigadier in the armies.

The marechal de camp, and assistant marechaux de camp.

The grade of Major-General (*Marèchal de Camp*) is very old. Before the reign of Henry IV there was a Major-General (*Marèchal de Camp*) in the armies, and he had under him assistant Major Generals (*Aides des Marechaux de Camp*). The duties of the Marèchal de Camp were, the ordering and regulating of marches and encampments, posting the grand guards, reconnoitring, &c. We see that originally this general officer exercised the functions now appertaining to the *Chief of the Staff* of the army.

Under Louis XIII and Louis XIV, the number of Major-Generals (*Marèchaux de Camp*) was greatly increased ; their duties were to command divisions of the army in battle, to execute particular operations, invest besieged places, and take command of fortresses that were threatened, and to be ever ready when on duty to execute the orders of the General. In fine, the *Marèchal de Camp*, or Major-General, was specially charged with the functions of the Chief of the Staff in modern armies.

The lieutenant-general.

The office of Lieutenant-General takes date from Charles VII (1430,) and for a long time designated the commander of an army not commanded by the chief magistrate or prince in person ; and it was in this acceptation of the title that Turenne was made Lieutenant General, when he succeeded Marshal Guèbriant, who was killed in the army in Germany. In those times the office was temporary, as is at present that of General in Chief; but since Louis XIII it has been a permanent grade.

Originally, towards 1635, there was but one Lieutenant-General in an army; but under Louis XIV there were many, and this grade became intermediate between that of Major-General (*Marèchal de Camp*), and the rank of Marshal of France. The functions of Lieutenant Generals were then the same as in our own days; they commanded detached corps of the army, and even armies, and in general orders of battle the wings and centre.

The rank of marshal of France.

The rank of Marshal of France was prior to the revolution the highest and most honorable military grade; and to be promoted to it, it was requisite to have passed through the grades of Major-General and Lieutenant-General. The origin of this rank is as remote as the year 1200, under Philip Augustus. At that period there was only one Marshal of France; but in the following reigns the number was successively increased, especially by Henry IV. Louis XIV augmented the number to sixteen in 1661; and after the promotions in 1703, there were twenty Marshals of France.

The office of quarter master general and chief of the staff or adjutant and inspector general.

The office of chief of the staff ("*major general*") and of quarter master general ("*marèchal general des logis*") take date from the reign of Louis XIV. The officers holding these important stations, performed under the orders of the *marèchal de camp*, the functions now appertaining to the chief of the general staff. The duties of the chief of the staff related specially to the infantry in the field; he accompanied the marèchal de camp to the encampment, and marked and distributed the ground to the majors of brigade, posted all guards, kept the rosters of duties, and in sieges commanded the guards of the trenches, and directed the workmen, &c.

The quartermaster general of the army ("*marèchal des logis "de l'armée"*) marked and distributed the ground of encampment for the regiments of cavalry, for head quarters, for the park, provisions, hospital, &c. reconnoitred for the route and march of columns, &c. and had under his direction the captains of guides and the waggon masters ("*vague-mestres*") with whom he regulated every thing concerning the baggage and equipages. Thus are the gradations of military rank and office, the fruit of ages of experience.

22. The infantry; its composition on a war establishment from 1776 to 1788; and the composition of the other arms of the French military force.

22. The infantry of European armies has been long divided into *infantry of the line* or battle, and *light infantry;* and since 1760 the French light infantry has been styled *rangers* ("*chas-*

"*seurs à pied*,") of which there was in every regiment one company, organized like the grenadier company; the latter was attached to the first battalion, and the former to the second. In 1784, six battalions of "*chasseurs à pied*" or rangers were raised, and attached to six regiments of "*chassuers à cheval*" or mounted rangers; but by the organization of 1793, all the light-infantry were formed into demi brigades, which are now called regiments.

In Europe, all infantry is organized into regiments composed of battalions. In 1776 the French infantry was divided into French infantry, properly so called, and into foreign infantry. There were 79 regiments of French infantry, of which 78 were of two battalions each, and one of four; each battalion was of five companies; that is, one of light infantry or grenadiers, and four battalion companies. The battalion company upon a war establishment consisted of 2 captains, 2 lieutenants, and 3 sub-lieutenants, 6 sergeants, 1 quartermaster's sergeant ("*fourrier*,") 10 corporals, 3 musicians and 150 privates; making a total strength on the war establishment of 177 men, of whom 7 were officers, and 47 non-commissioned officers. The company of grenadiers and light infantry was commanded by 2 captains, 2 lieutenants, and 2 sub-lieutenants, and consisted of 5 sergeants, 1 quarter master's sergeant ("*fourrier*",) 8 corporals, 2 musicians, and 80 privates orgrenadiers; making a total strength of 102 men, of whom 6 were officers and 14 non-commissioned officers. Hence the strength of the battalion was 811 men, including the lieutenant colonel.

The organization of the foreign infantry was the same as the national infantry, excepting the Swiss battalions whose companies were a little differently formed.

In summing up the force of these different corps of infantry, we have,

	Men.
1st. For 79 regiments containing 160 battalions and 79 colonels	129,839
2d. For 22 battalions of Swiss	11,368
3d. For 16 battalions of Germans	12,984
4th. For 6 battalions of Irish	4,870
5th. For 4 battalions of Italians and Corsicans	3,246
6th. For 78 garrison battalions of 4 companies	55,226

Strength of all the infantry upon a war establishment from 1780. to 1788: making nearly 268,000 men.

7th. For the regiment of Paris 1,622
8th. For 13 provincial regiments, of the artillery and general staff, of 2 battalions of 4 companies 16,200
9th. For 13 regiments of royal grenadiers of 4 companies 10,621
10th. For the regiment of French guards of 6 battalions of 5 companies, one of which grenadiers 4,885
11th. For the regiment of Swiss guards of 4 battalions of 4 companies, one of which grenadiers 2,372
12th. For 6 battalions of light infantry ("*chasseurs à pied*") or rangers, being part of the 6 regiments of light infantry, and light horse or mounted rangers; 4 companies per battalion, and each company on the war establishment containing 134 men, including 6 officers 3,222
13th. For 7 regiments of artillery of 20 companies, and 5 companies of miners; the whole constituting the forces of the corps of artillery, about....12,000

Total 268,455

Making the strength of the infantry on the war establishment, about two hundred and sixty-eight thousand men.

The cavalry and its organization from 1780 to 1788.

We have already seen that the cavalry has ever been of two kinds, viz. the light, and heavy or cavalry of the line; and these two species exist in all European armies under the formation of regiments and companies. By heavy or cavalry of the line ("*de bataille*"), we understand the ancient men at arms or *gendarmerie*, the brigade of carabiniers, and regiments of cavalry, cuirassiers, and dragoons. By light cavalry, we understand the ancient legions and companies converted into light horse ("*chasseurs à cheval*"), and the hussars. All cavalry regiments are composed of two or three, and sometimes four squadrons; the squadron contains one or two companies, according to the different modes of formation.

In the interval between 1780 and 1788, the cavalry of France consisted;—1st, of 4 companies of life guards; 2d, 8 free companies forming the *gendarmerie* corps; 3d, 1 regiment of carabiniers, divided into two brigades; 4th, 30 regiments of cavalry; 5th, 24 regiments of dragoons; 6th, 6 regiments of hussars; 7th, 6 regiments of mounted rangers ("*chasseurs à cheval*"): forming a total force of, viz.

	Men.
1st. 4 companies of life guards	1,500
2d. 8 do. .. gendarmerie	920
3d. 1 regiment of carabiniers	1,560
This corps was divided into 2 brigades, each brigade into 5 squadrons, and each squadron, upon a war establishment, composed of 150 troopers.	
4th. 30 regiments of cavalry	20,400
Each regiment of four squadrons or companies which on the war establishment contained 169 men, of whom 6 were officers and 14 non-commissioned officers: the strength of each regiment, including 5 superior officers, was 680 men.	
5th. 24 regiments of dragoons	16,400
Their formation was the same as the cavalry.	
6th. 6 regiments of hussars	4,080
Organization same as the cavalry.	
7th. 6 regiments of mounted rangers ("*chasseurs à "cheval*")	4,484
Each of 4 squadrons or companies, and each squadron on a war establishment consisting of 185 men, including 14 non-commissioned, and 22 officers and staff; making the strength of the regiment 744 men.	
Total	49,344

Together making nearly fifty thousand men of various kinds of cavalry prior to 1788.

Recapitulation of the strength of all arms in the French army on the war establishment, from 1776 to 1788: nearly 320,000 men.

The enumeration of all the forces of the army at the same period gives, viz.

			Officers.
1st.	Marshals of France - - 18 Lieutenant Generals - 225 Major Generals ("*Mare-* "*chaux de Camp*") - 538 Brigadiers of Infantry - 295 Brigadiers of Cavalry and Dragoons - - - - 167	General officers	1,243
2d.	21 brigades of the corps of engineers		329
3d.	Force of infantry, including the regiments of artillery and miners		*Men.* 268,455
4th.	Force of cavalry		49,344
	Total		319,371

(*In this enumeration we do not include the corps of sea-coast fencible cannoniers, amounting to about* 21,500 *men.*)

Thus in the year 1788, the military force of France was about 320,000 men.

23. Formation and force of the French army on a war establishment from 1788 to 1792.

23. In 1788 the French army experienced some slight changes in its strength and formation; it was in this year that the offices of "*mestre de camp en second*" and Colonels General, were suppressed. After these alterations the army remained almost untouched till the epoch of 1793, the commencement of the last war, when it was re-organized upon a new basis.

Formation and strength of the infantry on the war establishment in 1788.

The French infantry retained in 1788 the organization of light infantry, and infantry of the line or battle. The regiments of Royal Corsicans and Italians, and the "*corps de Montreal*," were reduced, and formed into battalions of light infantry or *chasseurs à pied*, which were augmented to 12 battalions by detaching the 6 battalions from the 6 regiments of *chasseurs à cheval* or mounted rangers. At this period the mass of infantry was composed of, viz. 1st, the regiment of French guards; 2d, the regiment of Swiss guards; 3d, 79 regiments of infantry of the line, of which one was of four battalions; 4th, 11 regiments of Swiss infantry; 5th, 8 regiments of German infantry; 6th, 3 regiments of Irish infantry; 7th, 1 regiment of infantry of Liege; together making 102 regiments or 206 battalions of the line: 8th, 12 battalions of light infantry or *chasseurs à pied*; 9th, the provincial militia, effective strength 76,000 men, to assemble in time of war to form the regiments of royal grenadiers, the garrison regiments, and the corps attached to the artillery and general staff of the armies; 10th, 7 regiments of artillery, and 5 companies of miners.

Force of the infantry on the great war establishment in 1788 and 1792; about 272,000 men!

And on estimating the strength of these different corps of infantry on the war establishment, we find the result to be, viz.

	Men.
1st. The regiment of French guards	4,855
2d. The regiment of Swiss guards	2,372
3d. 79 regiments of French infantry	131,814

78 of these were of 2 battalions, and 1 only of 4 battalions: each battalion consisted of 4 battalion, and 1 light infantry or grenadier companies. The strength of the grenadier company was 116 men, including 6 officers and 14 non-commissioned officers. The company of light infantry was 122 strong, 14 non-commissioned and 6 officers inclusive. The battalion companies were 173 strong, in-

cluding 17 non-commissioned and 6 officers: the staff of a regiment consisted of 26 men. Thus giving for the total force of a regiment on the great war establishment 1,648 men.

4th. 11 Swiss regiments of 2 battalions, and formation the same as the French regiments..... 18,128

5th. 8 regiments of German infantry of two battalions, and same formation as the French..... 13,184

6th. 3 regiments of Irish infantry of two battalions.... 4,944

7th. 1 regiment of Liege infantry..... 1,648

8th. 12 battalions of light infantry or *chasseurs à pied*. 7,548

These battalions consisted of 4 companies; the company on the great war establishment was 154 strong, of whom 14 were non-commissioned and 6 officers: the staff of the battalion consisted of 13 men. Thus the battalion on the great war establishment was 629 strong.

9th. The provincial militia 76,000

10th. 7 regiments of artillery and 5 companies of miners 12,000

Each regiment of artillery was of 20 companies, &c.

Total 272,523

Thus at the epoch of 1788, the infantry force of the nation was about two hundred and seventy thousand men.

The cavalry, its force and organization from 1788 to 1792.

In the organization of 1788, the cavalry was as before divided into light and heavy cavalry; the gendarmerie, and five of the highest numbered regiments of cavalry, were disbanded. The sum of the forces of the different corps was, viz.

Men.

1st. 4 Companies of Life Guards, ... 1,200

Each company formed one squadron, and was divided into 4 brigades: the company was 291 strong, of which 17 were superior, and 26 platoon officers.

The total strength of the cavalry on the great war establishment in 1788 and 1792; 35,800 men.

2d. The Brigade of Carabiniers, ... 1,360

The brigade consisted of two regiments or eight squadrons of two companies: the squadron was 163 strong, including 14 non-commissioned, and 9 officers.

3d. 24 Regiments of Cavalry, ... 12,000

Each regiment was of three squadrons of two companies. The strength of the squadron was 163 men, the 14 non-commissioned and 9 officers inclusive. The force of each regiment was 500 men.

Men.

4th. 18 Regiments of Dragoons, ... 9,000.
The regiment consisted of three squadrons, and the squadron of two companies. The strength of the squadron was 163 men, of whom 14 were non-commissioned, and 9 officers. The strength of the regiment was about 500 men.

5th. 6 Regiments of Hussars, ... 4,080.
The regiment had four squadrons, each of two companies. The strength of the squadron was 167, including 9 officers and 14 non-commissioned officers. Force of regiment 680 men.

6th. 12 Regiments of Mounted Rangers. (*Chasseurs à Cheval.*) ..... 8,160.
The regiment had four squadrons of two companies. The force of the squadron was 167 men, of whom 9 were officers and 14 non-commissioned officers. The regiment was 680 strong.

Total, 35,800.

These details exhibit a force of Cavalry in 1788 of nearly 36,000 men; consequently much inferior to the previous establishment. If we recapitulate all the forces of which the army was composed in 1788, viz.

Recapitulation of the French forces on the war establishment in 1788: total strength 309,000 men.

1st. { Marshals of France, ... 12. / Lieutenant-Generals, ... 160. / *Marechaux de Camp*, or Major-Gen'ls. 500. } Gen. Officers, 672.
2d. Corps of Engineers, divided into 21 brigades, .. Officers, 329.
3d. Infantry forces, including 7 regiments of Artillery, and the 5 companies of Miners, ... Men, 272,500.
4th. Cavalry forces, ... 35,800.

Total, 309,301.

(Note. The sea-coast fencible cannoniers (*les cannoniers gardes-côtes*), are not here included.)

The details of the organization of the French army at the periods anterior to the last war, prove that it was not stronger than the armies of the king of Prussia or emperor of Russia; and that it was inferior in numbers to the armies of the emperor of Germany.

The force of the infantry was about the same from 1704 to 1792; but the cavalry sustained a reduction of about 12,000 men in 1788, exclusive of the diminution caused by the reduction of the king's household troops in 1775.

The artillery and engineers.

We do not here particularize the constitution and formation of the artillery and engineers, because we shall make them the subject of a separate chapter.

24. Constitution of the French army: formation of forces of the different kinds and species of arms, from 1791, 1792, and 1793, to 1804.

24. In the interval between 1789 and 1793, the French army suffered great reductions. The system of militia was abolished; numerous battalions were levied in the provinces, and marched to the fortresses or camps on the frontiers. The Swiss troops were disbanded, and the life-guards suppressed, together with all the foreign regiments; and the army was constituted of *national* cavalry and infantry. The French guards were organized into three regiments, which took rank in order of battle: two more battalions of light infantry (*chasseurs à pied*) were raised, and made the whole number amount to 14 battalions. The number of regiments was at this time 105, which after 1791 consisted each of two battalions, and the battalion of 9 companies, including one of grenadiers. The companies were by law 56 strong, 3 officers inclusive. So that in 1792 there were but 110,000 infantry of the line, including the 11 regiments of Swiss, which were soon after disbanded, and thus reduced the infantry to about 100,000 men. In 1791 the light infantry companies or rangers were suppressed in the regiments.

This force of infantry of the line, united to more than 250 battalions of volunteers, was distributed into brigades to form the different armies.

Besides battalions of volunteers, there were raised independent companies, and battalions and legions of light infantry and cavalry, which considerably augmented the light troops. There was therefore no longer companies of light infantry in the battalions of the line, from which all the light infantry was completely detached. No sooner had the battalions of volunteers arrived in the camps and strong places, than the inconvenience was felt of having two kinds of infantry of the line; the one accustomed to military discipline and manœuvres, and the other zealous to acquire discipline and information, and animated by ardour and courage, but still raw in all the branches of service. In this state of things the government conceived and executed the bold plan of re-organizing the army in the face of hostile armies,* by amalgamating two battalions of volunteers

* This was not the first attempt to organize an army in the face of the

with every one battalion of regular infantry of the line. The new corps thus created were of three battalions, and called *Demi-Brigades* of infantry of the line, and commanded by a *Chief of Brigade;* and each battalion was commanded by a lieutenant-colonel, styled Chief of Battalion. The commandants of the regiments of cavalry took also the title of Chief of Brigade; and these new denominations extended through all corps of the army.

The demi-brigade of the line, and the substitution of chief of brigade and chef of battalion, for the titles of colonel and lieutenant-colonel.

The Swiss regiments having been disbanded, there were 188 battalions of the line received into the demi-brigades, under the new organization.

Organization of the infantry of the line into 198 demi-brigades.

The law of the 12th August, 1793, regulated the organization of the infantry of the line into 198 demi-brigades. In this formation, which is of great simplicity, the battalion of about 700 men, was taken according to the old mode, as an unit of force.

Composition of the demi-brigade of three battalions.

Each demi-brigade was composed of three battalions, designated, first, second, and third; and taking rank in line from right to left.

Each battalion consisted of 9 companies, (one of grenadiers, and eight battalion companies,) numbered from right to left in the order of battle.

Formation of grenadier and battalion companies; the platoon, section, & squad.

Each company of grenadiers was commanded by a captain, a lieutenant, a sub-lieutenant, and 8 non-commissioned officers.

Each battalion company was commanded by 3 officers and 11 non-commissioned officers. It must be observed, that the company in the order of battle is called *platoon*.

enemy; nor will it be the last. In the year 1775, General Washington dissolved one army of militia and organized another almost under the cannon of the British army in Boston; and what is worthy of remark, the British were superior in numbers, quality of troops, and in artillery, arms and ammunition, of all of which our army was lamentably destitute. It cannot be doubted, that if General Gage could have shaken off the panic of Breed's (Bunker's) Hill, and marched out, the American army must have been overwhelmed by immensely superior numbers, discipline and weapons. General Washington calculated on the *man*, as well as on the spirit and circumstances of the cause.

In the war of the Revolution, this attempt to re-organize an army in the face of an enemy of superior force, was frequently repeated, and with success. It was attempted in consequence of dire necessity; and it succeeded—because of the ignorance and *incapacity* of the *British* Generals. It is therefore to be admired, not to be imitated. TRANSLATOR.

The platoon, or company of *grenadiers*, was divided into two sections, and the section into two squads.

The platoon, or *battalion* company, was divided into two sections, and the section into three squads.

Each section was commanded by a sergeant, and each squad by a corporal.

Volunteer companies of cannoniers.]

The same law attached to each demi-brigade a company of volunteer cannoniers 75 strong, of whom 66 were privates or cannoniers; and this company of artillery was to serve six field pieces. But as this plan was abandoned as vicious and inconvenient, we shall not take it into view in our estimates.

The three following Tables exhibit all the details of the formation and strength of a demi-brigade.

Strength of the infantry of the line in 1793.

The force of the demi-brigade of infantry of the line being 2356 men, hence this organization of 198 demi-brigades produced a force of 460,000 men.

Alterations in this primitive organization.

A short time after this first organization, there were some slight changes, as well in the number of demi-brigades, as in their primitive formation.

Of the number of demi-brigades from 1800 to 1804, and battalion formation into companies.

For the 8th year (1800) the number was reduced 110 demi-brigades, each composed as before of 9 companies, including one of grenadiers; but the strength of the battalion was increased to 1067 men, including officers.

Each company of grenadiers was 90 strong; and each battalion company's force was 120 men.

The platoon was divided into two sections, and the section into four squads, both in the grenadier and battalion companies.

The three following Tables exhibit all the details of the formation of the company, battalion, and strength of the demi-brigade

TABLE,

Exhibiting the formation of a Battalion Company.

CAPTAIN.

Platoon.

FIRST SECTION. Lieutenant. SECOND SECTION. Sub-Lieutenant.

SERGEANT-MAJOR.

Quarter-Master's Sergeant (*Fourrier*).

SQUADS.

	1 Serg		2 Serg		3 Serg		4 Serg	
	1st	2d	3d	4th	5th	6th	7th	8th
Corporals . . . . . the	1st	2d	3d	4th	5th	6th	7th	8th
Privates	12	13	13	13	13	13	13	13
Strength of each squad,	13	14	14	14	14	14	14	14

Strength of 8 squads, ... 111 Men.
Non-commissioned officers and music, . . 8
Officers, ... 3

Total strength, ... 122

TABLE,

Exhibiting the formation of a Company of Grenadiers.

CAPTAIN.

Platoon.

FIRST SECTION. Lieutenant. SECOND SECTION. Sub-Lieutenant.

SERGEANT-MAJOR.

Quarter-Master's Sergeant (*Fourrier*).

SQUADS.

	1 Serg		2 Serg		3 Serg		4 Serg	
	1st	2d	3d	4th	5th	6th	7th	8th
Corporals . . . . . the	1st	2d	3d	4th	5th	6th	7th	8th
Grenadiers	8	9	9	9	9	9	9	9
Strength of each squad,	9	10	10	10	10	10	10	10

Strength of 8 squads, ... 79 Men.
Non-commissioned officers and music, . . 8
Officers, ... 3

Total strength, ... 90

TABLE,

Exhibiting the strength of a Demi-Brigade or Regiment of Three Battalions.

STAFF.

		Officers.	Soldiers
Chief of Brigade, or Colonel	1	9	
Chiefs of Battalions	3		
Adjutants (*Adjudans-Majors*)	3		
Quarter-Masters	2		
Sergeants-Major of Battalion	3	....	20
Surgeon and Assistant Surgeons	3		
Drum Major	1		
Drum Corporal	1		
Musicians	8		
Master Workmen	4		

BATTALIONS.

	1st	2d	3d	Total		
Captains	9	9	9	27	81	
Lieutenants	9	9	9	27		
Sub Lieutenants	9	9	9	27		
Sergeants Major	9	9	9	27		
Quarter Masters' Sergeants (*Fourriers*)	9	9	9	27	....	3117
Sergeants	36	36	36	108		
Corporals	72	72	72	216		
Grenadiers	71	71	71	213		
Privates	824	824	824	2472		
Drummers	18	18	18	54		
Strength of each Battalion	1066	1066	1066	3198		
Total					90	3137
Total strength of the Demi-Brigade					3227	Men
Number of Combatants					3203	

By this organization the Demi-Brigade was 3227 strong, of whom 3200 were combatants: therefore 110 Demi-Brigades give 354,970 men, of which about 352,000 are combatants.

Strength of the Demi-Brigade, and of the 110 Demi-Brigades of the line; 354,970 men.

The Brigade was formed by the union of two Demi-Brigades in the order of battle, commanded by a *General of Brigade*: this title was substituted for that of *Marechal de Camp*. The

The Brigade and Brigadier-General.

Strength of the brigade.

force of the brigade is 6454 men, of whom about 6400 are combatants.

The division of infantry of the line of 12,800 combatants; and the General of division.

A Division of Infantry of the Line, is the union of two brigades in line, under the command of a *General of Division*: this title was substituted for that of Lieutenant General.

The complete division.

In another place we will treat more fully of the *complete division*, which is a combined corps, and an integral part of a grand army operating in a campaign.

The light infantry and its organization into 30 demi-brigades.

At the commencement of the last war there were, as we before (23.) showed, twelve battalions of light infantry or *Chasseurs à pied*, and many other special corps were raised on the breaking out of the war. In 1793 all these corps were considered proper materials wherewith to form demi-brigades of light infantry, which were accordingly formed of battalions of volunteers, in the same manner as the infantry of the line. This organization was undertaken during a most active war, and required time to be completely executed. It produced thirty demi-brigades, formed into battalions and companies like the infantry of the line; each battalion of nine companies, one of which was riflemen (*Carabiniers*) formed like the Grenadier Companies.

Strength of the light demi-brigade, and of the 30 light infantry demi-brigades.

The light demi-brigade being of the same strength as the demi-brigade of the line, that is, 3227 strong or 3200 combatants, these thirty demi-brigades give a force of 96,810 men, or 96,000 combatants.

Total force of the infantry of the French military power, 451,780 men. or 448,000 combatants

By adding together the forces of these two kinds of infantry, we find that the total strength of the infantry from the 8th year to the 12th (1800 to 1804), was about 451,780 men, of whom 448,000 were combatants.

The cavalry, its formation and force from 1800 to 1804.

The cavalry was not during the last war placed on such a formidable footing as the infantry; all the operations were based upon the powers of this latter arm, to which all others should be subordinate.

The several kinds of cavalry.

The cavalry is now divided into several kinds, deriving their origin from those primitive military institutions that we have passed in review.

1st. The *heavy or cavalry of the line*, comprehending the *cavalry proper*, the *cuirassiers*, and the *carabiniers*.

2d The *dragoons*, a species of mounted infantry who, like the cavalry, enter into line.

3d. The light cavalry, comprehending the hussars, and *chasseurs* or light horse or rangers.

Formation of cavalry into squadrons, regiments, brigades, and reserves.

The cavalry in general is organized in units of force or squadrons; each squadron consisting of two companies, and three squadrons making a regiment.

The brigade.

The uniting of 2 to 4 regiments in order of battle, constitutes a *brigade.*

The reserve.

A *reserve of cavalry* is a body of 10 to 12 regiments, about 6000 strong, commanded by a *General of Cavalry*, and is always accompanied by a *company* of *horse* artillery.

In 1791 the regiments of cavalry and dragoons were formed of three squadrons of three companies each; those of *chasseurs* and hussars were of 4 squadrons. But in 1793 and to 1804, the formation of the cavalry was, as we are about to detail.

The brigade of carabiniers, composed of two regiments: total force 1406 men, or 1330 combatants.

The brigade of carabiniers is composed of 2 regiments of 4 squadrons, of the same formation as the cavalry. These regiments were each 703 strong, of which 696 were mounted, and including 28 officers. Therefore the force of the brigade was 1406 men, of whom 1390 were combatants.

The 25 regiments of cavalry of 3 squadrons; total 13,273 strong or 12,875 combatants.

There were 25 regiments of cavalry, formed of 3 squadrons each; the squadron composed of two companies, and the company about 85 strong, including officers: consequently the strength of a regiment was 531 men or 524 horsemen, of whom 515 are combatants. Therefore the total force of the 25 regiments is 13,273 men or 12,875 combatants.

The following table exhibits the formation and strength of a cavalry regiment of three squadrons:—

TABLE,

Showing the composition and strength of a Regiment of Cavalry of three squadrons.

STAFF.

			Officers	Troopers
Chief of brigade, or Colonel	1			
Chiefs of squadrons	2		4	
Quarter Master (*Quartier Maitre*)	1			
Chief Surgeon	1		2	
Assistant Surgeon	1			
Sergeants Major	2	mounted.		
Farrier or Veterinary	1			
Master Saddler	1			
Master Armourer	1	*not*		
Master Taylor	1	mounted.		15
Master Boot-maker	1			
Master Breeches-maker	1			
Chief Trumpeter (*Brigadier Trompette*)	1	mounted.		
Trumpeters	6			

SQUADRON.

Captains	2			
Lieutenants	2	6	18	
Sub-Lieutenants	2			
Sergeants Major (*Maréchaux des Logis en Chef*)	2			
Sergeants (*Maréchaux des Logis*)	4			
Quarter Masters Sergeants (*Brigadiers Fourriers*)	2	164		492
Corporals (*Brigadiers*)	8			
Troopers, including 2 blacksmiths or shoeing farriers	148			
Total strength of the squadron	men,	170		
	horses,	164		
			24	507
Total strength of regiment,	men,	531	22 officers,	
	horses,	524	502 troopers.	
Number of combatants,		515		

The 20 regiments of dragoons of 4 squadrons, making a total force of 19,000 men.

The 20 regiments of dragoons were formed of 4 squadrons each; the squadron of two companies, and the company, including officers, 114 strong, of which 110 were mounted. Hence the strength of a regiment was 943 men, of whom 938

were mounted; and the 20 regiments gave a total force of 18,860 men; but of this number only 18,760 were mounted.

The regiments of mounted rangers or light horse (*chasseurs*), were like the dragoons of 4 squadrons of two companies; making in the 25 regiments 23,575 men, or 23,450 horsemen.

The 25 regiments of *chasseurs a cheval* of 4 squadrons each, and 23,400 combatants

The regiments of hussars were like the chasseurs of 4 squadrons; and the 12 regiments gave a total force of 11,316 men or 11,256 horsemen.

The 12 regiments of hussars of 4 squadrons each; making about 11,200 combatants.

The following table shows the formation of a regiment of dragoons or light cavalry of 4 squadrons:—

TABLE,

Showing the Composition of a Regiment of Dragoons of four squadrons.

			Officers	Dragoons
STAFF.				
Chief of brigade or Colonel	1			
Chiefs of squadrons	2		4	
Quarter Master (*Quartier Maitre*)	1			
Chief Surgeon	1	*not* mounted	1	
Adjutant	2	not mounted	2	
Sergeants Major	2	mounted.		
Farrier or Veterinary	1	mounted.		
Master Workmen	4	not mounted		24
Chief Trumpeter	1	mounted.		
Trumpeters	16	mounted.		
SQUADRON.				
Captains	2			
Lieutenants	2	8	32	
Sub-Lieutenants	4			
Sergeants Major (*Marechaux des Logis en Chef*)	2			
Sergeants (*Marechaux des Logis*)	8			
Quarter Masters Sergeants (*Brigadiers Fourriers*)	2	220		330
Corporals (*Brigadiers*)	16			
Dragoons	192			
Total of the squadron, men		228		
Total of the squadron, horses		228		
Totals			39	904
Total of the regiment, men		943	38 officers,	
Total of the regiment, horsemen		938	900 dragoons.	
Number of combatants		919		

Total strength of the *arm* of cavalry, 68,432 men.

Adding together all these kinds of force, we find the whole strength of the cavalry 68,432 men, but only 67,565 *horsemen.*

The artillery; and the composition and strength of the forces in the artillery service.

The artillery service (*le personnel de l'arme de l'artillerie*) comprehends, 1st, the troops that manœuvre the pieces; 2d, the workmen who execute all the works in relation to this arm; 3d, the artillery drivers, formed into battalions of the *artillery train* (each battalion of 5 companies, one of which is *elite* and attached to the horse artillery); 4th, the companies of workmen; 5th. the regiments of pontonniers.

Division of the artillery into *two* kinds.

The artillery is divided into two kinds, the foot artillery, and the flying or horse artillery. The former consists of 8 regiments of 20 companies each, and the latter is formed into 8 regiments of 6 companies each.

The 8 regiments of foot artillery: their strength and formation on a war establishment 15,192 men, or 13,312 combatants (See "L'aide-Memoire; by Gen. "Gassendi"

The formation of a company of artillery is calculated for the service and manœuvring of 6 pieces, at 8 men to a piece, and to supply the wants of the park and casualties. Its strength on the war establishment is 94 men, inclusive of 6 officers, of whom 83 are combatants. Consequently the force of a regiment is 1899 men, or 1664 combatants. The eight regiments give a total force of 15,192 men or 13,312 combatants.

The full war establishment should be to the peace establishment, in the proportion of 8 to 5.

The following table exhibits the formation of a regiment of artillery on the war footing :—

TABLE,

Exhibiting the formation of a Regiment of Foot Artillery of twenty companies on the war establishment.

			Officers.	Matrosses
STAFF.				
Chief of brigade or Colonel	1			
Chiefs of battalions	6			
Adjutant	1	....	10	
Quarter Master	1			
Chief Surgeon	1			
Sergeants Major (*Adjudans ordinaires*)	5			
Drum Major	1			
Master Taylor	1	....		9
Master Cordwainer	1			
Master Armourer	1			
COMPANY.				
Captain	1			
Captain Lieutenants, one of whom at the regimental head quarters	2	6, and for 20 companies.	120	
First Lieutenant	1			
Second Lieutenants	2			
Sergeant Major (*Sergent Major*)	1			
Sergeants	4			
Quarter Masters Sergeant (*Corporal Fourrier*)	1	88, and for 20 companies.		1760
Corporals	4			
Musicians	2			
Artificers in fire-works	4			
Workmen, 2 in wood & 2 in iron	4			
First Cannoniers or Matrosses	28			
Second do. or do.	40			
			130	1769

Total strength..... .....1899 men.

Number of combatants per company	officers 5 soldiers 78	83 men.
Ditto do. .. regiment	officers 104 soldiers 1560	1664 men.

The regiment of horse artillery is of 6 companies; the force and formation of the company is calculated for the service and manœuvering of 6 pieces of artillery with 10 men to each, the service of the park, and supplying casualties. Its force upon a war footing is 94 men including 6 officers, of whom 87 are combatants. Therefore the regiment is 574 strong, or of 526

The eight regiments of horse artillery; their strength and formation on a war footing, 4592 men, or about 4200 combatants.

combatants; consequently we have for the whole force of the eight regiments 4592 men, or 4208 combatants.

The complete war establishment should be to the peace establishment, in the proportion of 10 to 5.

The following table shows the formation and details of the regiment :—

TABLE,

Exhibiting the formation of a Regiment of Horse Artillery of six Companies.

			Officers	Matrosses
STAFF.				
Chief of brigade or Colonel	1			
Chief of squadron	1			
Quarter Master	1		4	
Adjutant	1			
Sergeant Major (*Adjudant sous officier*)	1			
Chief Trumpeter	1			
Farrier or Veterinary	1			6
Saddler	1			
Boot-maker	1			
Taylor	1			
COMPANY.				
Captain	1	6, and for 6 companies.	36	
Captain Lieutenants; one at the regimental head quarters	2			
First Lieutenant	1			
Second Lieutenants	2			
Sergeant Major (*Marèchal des Logis en Chef*)	1	88, and for 6 companies.		528
Sergeants (*Marèchaux des Logis*)	3			
Quarter Masters Sergeant (*Brigadier Fourrier*)	1			
Corporals (*Brigadiers*)	3			
Trumpeters	2			
Artificers, 1 in wood, 1 in iron, 1 farrier, 1 harness maker	4			
First Matrosses or Cannoniers	29			
Second do. do.	45			
			40	534

Total strength of the regiment ..... 574 men.

Number of combatants per company	officers, 5; soldiers, 82	87 men.
Number of combatants per regiment	officers, 34; soldiers, 492	526 men.

The 12 companies of artificers employed in works for the artillery, consist of 79 men each, inclusive of officers; making together a force of 948 men.

Twelve companies of artificers 948 strong, attached to the artillery.

There were two regiments of pontonniers attached to the artillery service; each regiment consisted of 8 companies, and each company 62 strong, of which 2 are officers. Each regiment, including its staff, was 499 strong; therefore the two regiments give a total force of 998 men.

Two regiments of pontonniers attached to the artillery.

Besides the officers attached to the regiments of artillery, there are general and superior officers for the service of inspections, and direction of the manufactories of arms, and the service of parks in separate armies; viz.

General and field officers employed in the artillery, and not included in the regiments.

Chief Inspector-General of Artillery	1	
Inspecting Major-Generals	6	
Inspecting Brigadier Generals	10	
Superintending Colonels (*Chefs de Brigade Directeurs*)	28	116
Sub-Superintending Lieutenant-Colonels (*Chefs de Bataillon sous Directeurs*)	31	
Colonels and Lieutenant-Colonels (*Chefs de Brigade & de Bataillon*) in the train, about	40	

GENERAL SUMMARY

Of all the forces of the arm of Artillery on the War Establishment.

	Officers	Soldiers
Inspector-Generals, Directors, Sub-Directors, Chiefs of Brigade, &c. . . .	116	
12 companies of Artificers	48	900
2 regiments of Pontonniers	38	960
8 regiments of Foot Artillery . . .	1,040	14,152
8 regiments of Horse Artillery . . .	320	4,272
	1,562	20,284
Total		21,846
Number of combatants, about		17,600

Total strength of the artillery, 21,846 men.

The artillery officers employ, in peace and war, civil artificers of all trades to execute works under their direction: in the field, detachments of fatigue men are furnished them from the infantry.

The service of the engineers' corps consists of; 1st, a corps of 450 officers; 2d, 6 companies of miners; and 3d, 4 battalions of sappers.

Service of the engineers' corps and its formation, containing 7668 men and 593 officers.

In peace and war the officers employ in the construction of works civil artificers of all trades; and in the field, detachments of fatigue men are drafted from other corps for the execution of these works.

GENERAL SUMMARY

Of the Troops of the Engineer Corps.

		Officers	Soldiers.
Chief Inspector General	1		
Inspector Generals	6		
Directing Chiefs of Brigade or Colonels	34		
Sub-Directing Chiefs of Battalions, or Lieutenant-Colonels	68	449	
Captains	260		
Lieutenants	80		
6 companies of Miners		24	576
4 battalions of Sappers of 9 companies of 200 men each; viz.			
Staff	12		
Captains	36	120	
Lieutenants	36		
Sub-Lieutenants	36		
Sappers			7092
		593	7668
Grand total		8261	Men.

Total force of the French army from 1799 to 1804, 550,619 men.

The aggregate of all the forces of the different *arms*, is 550,619 men, of whom 540,800 carry arms, including the miners and sappers.

The following Table exhibits the whole force and different arms, composing the French army in 1803 and 1804:

TABLE

Of all the Troops and Corps composing the French Armies.

		Officers	Soldiers.
Generals of Division employed in the armies to command divisions of infantry, reserves of cavalry, strong places and departments: about	100	110	
Generals of Division, of artillery	7		
Generals of Division, of engineers	3		
Generals of Brigade serving in the line or in commands, about	200	214	
Generals of Brigade, of artillery,	10		
Generals of Brigade, of engineers	4		
110 demi-brigades of infantry of the line		9,900	345,070
30 demi-brigades of light infantry		2,700	94,110
2 regiments of carabiniers		56	1350
25 do of heavy cavalry		600	12,675
20 do of dragoons		780	18,080
25 do of chasseurs		975	22,600
12 do of hussars		468	10,848
8 do of foot artillery		1,040	14,152
8 do of horse artillery		320	4,272
Chiefs of Brigade, and Battalion, Directors and Sub-Directors of artillery		99	
Chiefs of Brigade and Battalion, Directors and Sub-Directors of engineers; and Captains and Lieutenants of engineers		442	
12 companies of artificers in the artillery		48	900
2 regiments of pontonniers		38	960
6 companies of miners		24	576
4 battalions of sappers		120	7,092
		17,934	532,685
Grand total			550,619

Proportions and ratios between each arm and the whole army, and between the several corps.

From the preceding tables it is easy to establish the relative proportions that existed in the military force of 1800, between *each arm* and the *total* force of the army; likewise the ratio which the several corps bore to each other.

TABLE

Of Ratios or Proportions.

Total force of all arms 549,000 men, expressed by 1.0000					
Infantry of the line 355,000	} 451,700 men.	do	0.6466	}	0.8227
Light Infantry . . 96,700		do	0.1761		
Cavalry 14,500	} 33,200	do	0.0264	} 0.0605	
Dragoons 18,700		do	0.0341		0.1237
Light Cavalry . . 34,700	} 67,900 men.			0.0632	
Artillery 21,400					0.0390
Engineers 8,000					0.0146
	549,000 men. expressed by =				1.0000

Thus we see, that the infantry is the principal arm and is $\frac{4}{5}$ of the whole force, whilst the cavalry is only $\frac{1}{4}$. the artillery $\frac{1}{25}$, and the engineers $\frac{1}{61}$ part. The cavalry is to the infantry as 1 to 7. and the artillery as 1 to 21 : and the engineers to the artillery as 5 is to 13.

The present constitution of the French army 1804 : the style of regiment and Colonel established the formation of brigades and Corps of brigades

25. The present constitution of the French army does not materially differ from the preceding exposition: but as there have been improvements made, it is necessary to the completion of our task to notice them. This last organization is not yet well known ; we therefore cannot strictly give all its details, which are however of no great moment to our purpose.

All the corps of infantry and cavalry are now called *regiments*, and are distinguished according to their rank in the order of battle, in the same manner as were the demi-brigades for which they are substituted. The commanders of regiments have the title of *Colonel*.

Organization of the infantry into regiments, battalions, and companies : the force of a regiment on the war establishment of 4 battalions, 4200 men, or about 4700 combatants

There are now in the French army 90 regiments of infantry of the line, and 27 regiments of light infantry ; each regiment of 4 battalions, and the battalion of 9 companies, one of which is grenadier, or riflemen (*carabiniers*). The regimental staff is composed of 1 colonel, 1 major, 4 chiefs of battalion, &c. We will suppose that the grenadier and battalion companies are constituted on a war establishment as detailed in the preceding Tables : the formation of 4 battalions is founded upon the excellence of having *three* battalions in the *field*, and *one of depôt* in the strong places, to discipline recruits and supply the casu-

alties of the three battalions in the field. These fourth battalions perform at the same time the service of the fortresses.

Supposing the battalion on the war establishment to be 1,066 strong, we have for the regiment a force of 4,293 men, including 34 of the staff; viz. 1 colonel, 1 major, 4 chiefs of battalion, 4 adjutants, 4 sergeants-major, &c. or about 4,180 combatants.

The consular guard of *infantry*, about 4000 men.

We must notice the *infantry* of the consular guard, as it is destined to serve with the armies and enter into line. It consists of 2 battalions of grenadiers, and 2 battalions of chasseurs; each battalion of 8 companies, and the whole forming a force of about 4000 men.

Total force of the infantry of the line and light infantry on the war establishment, 507,066 men.

In summing up these forces of infantry, we have,	*Men.*
For 90 regiments of the line of 4 battalions	386,820
27 do. of light infantry of do.	116,046
the consular guard	4,200
	507,066
or 490,000 combatants.	

Formation of the cavalry.

The cavalry is now formed into regiments of 4 squadrons of 2 companies each, and divided into, 1st, *the cavalry of the line*, comprising 2 regiments of carabiniers, 12 regiments of cuirassiers, and 30 regiments of dragoons; 2d, *the light cavalry*, composed of 24 regiments of chasseurs, and 10 regiments of hussars; 3d, *the cavalry of the guard*, composed of horse grenadiers in 4 squadrons, each of two companies, and of the corps of *chasseurs à cheval* or mounted rangers, in 4 squadrons of two companies.

Total force of cavalry, about 71,000 men.

To complete our summary of the cavalry, we will suppose the present strength of the squadron the same as in the preceding tables, and we have,

	Men.
For 2 regiments of carabiniers of 4 squadrons	1,406
12 do. .. cuirassiers	8,412
the horse grenadiers of the guard	710
30 regiments of dragoons.....	28,290
24 do. .. chasseurs	22,632
10 do. .. hussars	9,430
the chasseurs of the guard	710
	71,590
or 69,800 combatants.	

The artillery and its organization into regiments and companies.

The service (*le personnel*) of the artillery has not sustained any sensible modifications, except the reduction of the regi-

ments of horse artillery from 8 to 6, and the organization of the companies of the train into *sixteen battalions* of the train, of which eight are principal battalions, and eight *suppletory*; and the augmentation of the companies of artificers from twelve to fifteen. The troops (*personnel*) of this arm therefore consist of, 1st, 230 general and field officers employed in the general inspection, and in the direction of the material of the arm; 2d, eight regiments of foot artillery; 3d, 6 regiments of horse artillery; 4th, 8 principal and 8 suppletory battalions of the train; 5th, the corps of pontonniers, consisting of two battalions.

Total force of the artillery. 21,485 men, or 17,200 combatants.

In summing up, we will take for basis the preceding tables, which approximate as near as necessary, and give the following result:—

GENERAL SUMMARY

Of the Forces of the Artillery Service on the war establishment, according to the formation of the 12th year (1804).

	Officers	Men.
First Inspector General	1	
Inspector Generals, Directors, and Sub-Directors, having the rank of Generals of division, Generals of brigade, Colonels, and Chiefs of battalions or Lieutenant Colonels	230	
3 regiments of foot artillery of 20 companies	1,040	14,152
6 do. .. horse artillery of 6 companies	240	3,444
The corps of horse artillery of the guard, one squadron of 2 companies . . .	15	180
2 battalions of pontonniers	38	960
15 companies of artificers	60	1,125
Totals	1,624	19,861
Grand total	. 21,485 men.	
Number of combatants about	17,200 men.	

The engineers' corps in 1804, and its force 10,371 men.

The present organization of the engineers, is the same as heretofore, and consists in, 1st, a corps of about 450 officers; 2d, 9 companies of miners; 3d, 5 battalions of sappers of 9 companies each.

GENERAL SUMMARY

Of the Forces of the Engineer Corps, according to the organization of 1804.

	Officers.	Soldiers.
First Inspector General	1	
Inspector Generals, Directors, and Sub-Directors	120	
Captains and Lieutenants	320	
9 companies of miners	36	864
5 battalions of sappers	165	8,865
The company of about 200 men, including 3 officers, and giving for each battalion 1806 men, including the staff.		
Totals	642	9,729
Grand total . .	10,371 men.	

Recapitulating the different forces forming the army of France in 1804, we find them to amount to about 610 thousand men.

Total force of the army in 1804, 610,000 men.

SUMMARY

Of the Troops of all arms on the war establishment, constituting the French army in 1804.

	Officers.	Soldiers
GENERAL STAFF.		
Generals of divisions of all arms, including 9 of the artillery and 3 of the engineers - - -	130	
Generals of brigade, 13 of artillery and 6 of the engineers - - - - - - - - - - - -	241	
Adjutants Commandant or Adjutants General -	124	
INFANTRY.		
117 regiments of infantry and the corps of guards, making 472 battalions - - - - - - - -	13,442	493,624
CAVALRY.		
78 regiments and the corps of the guard, making 320 squadrons - - - - - - - - - -	2,246	69,344
ARTILLERY.		
Superior officers - - - - - - - - - - -	209	
8 regiments of foot artillery - - - - - - -	1,040	14,152
6 do. .. horse artillery - - - - - - -	240	3,444
Corps of artillery of the guard - - - - - -	15	180
2 battalions of pontonniers - - - - - - -	38	960
15 companies of artificers - - - - - - - -	60	1,125
ENGINEERS.		
Superior officers, Captains, and Lieutenants -	432	
9 companies of miners - - - - - - - - -	36	864
5 battalions of sappers - - - - - - - - -	165	8,865
	18,418	592,558
Grand total - - - - - -	610,976 men.	

The proportions of the force of each arm, to the whole force.

To determine the proportions between the different arms composing the army, the organization of which we have just delineated, we will take for data the preceding tables or summaries, and rather under-rate the results that they furnish.

TABLE,

Exhibiting the proportions between the different arms of the army, according to the preceding formation.

Total force,	610,500 men,	expressed by	1.0000
Infantry,	500,000 ..	do.	0 8313
Cavalry,	70,000 ..	do.	0.1164
Artillery,	21,500 ..	do.	0.0357
Engineers,	10,000 ..	do.	0 0166

In this latter formation, as in the preceding (both taken on the war establishment), the infantry is the principal arm, and is $\frac{5}{6}$ of the whole force; whilst the cavalry is only about $\frac{1}{8}$, the artillery $\frac{1}{28}$, and the engineers $\frac{1}{60}$. Thus the infantry is to the cavalry as 3 is to 20; but as the infantry has many battalions "*de depôt*," and is to garrison the fortresses, &c. the effective proportion of the two arms is as 1 to 5. And this proportion is the best for separate armies executing plans of campaign.

An army thus constituted, commanded by able and experienced Generals, and maintained by a military conscription, best attests the power of a nation and the strength of a government*.

25. General reflections on the armament of the troops of modern Europe

25. We have shown (in art. 10 and 12) the offensive and defensive material arms with which the troops of modern Europe are equipped, and the successive modifications introduced by time, invention, and the progress of the arts. We will devote to this subject a few reflections to guide those students who are desirous of extending their knowledge in this part of the science of war.

On the armament of the cavalry.

We have seen (in art. 12) that it was about the year 1600, and during the interval which separates the reigns of Henry II and Henry IV, that the use of the lance was almost entirely

* The following Table shows the strength and organization of the regular army of the United States towards the close of the last war, (1815).

abolished in the cavalry of the line, whose principal weapon was the broad and straight swords. The reasons of this change will be obvious when we come to treat of the orders of battle for cavalry. The lance however was not totally abandoned, but

Organization of Regiments, Corps, and Companies.

COMPONENT PARTS OF THE ENGINEER CORPS.

	Colonel	Lieut. Colonel	Majors.	Captains	First Lieutenants.	Second Lieutenants.	Paymaster.	Sergeants	Corporals.	Teacher of Music	Musicians.	Artificers	Bombardiers.	Aggregate strength.
Corps of Engineers	1	1	2	6	6	6	1	4	4	1	8	60	50	150

COMPONENT PARTS OF REGIMENTS AND CORPS.

Regiments and Corps.	Colonels	Lieutenant-Colonels.	Majors.	Adjutants	Quarter-Masters.	Pay-Masters.	Surgeons.	Surgeon's Mates	Serjeant-Majors	Quarter Mast.-Serjts	Principal Musicians	Principal Farrier	Riding-Masters	No of Troops.	No. of Companies	Strength of a Regiments.	Strength of Battal	No. of Regiments.	No of Battalions.	Aggregate.
Light Artillery	1	1	2	1	1	1	1	1	1	1	2	..	.	10	.	963	..	1	..	963
Dragoons . . .	1	1	2	1	1		1	2	1	1	1	1	1	8	.	981	.	1	..	981
Corps Artillery .	..	6	6	12	12		..	..	..	..	..	..	..	..	48	.	495	...	12	5940
Infantry	1	1	2	1	1	1	1	2	1	1	2	..	..	..	10	1094	.	46	..	50324
Riflemen . . .	1	1	2	1	1	1	1	2	1	1	2	..	..	..	10	1060	..	4	..	4240
																Total authorized force				62448

COMPONENT PARTS OF A TROOP AND COMPANY.

Regiments and Corps.	Captains.	First Lieutenants.	Second Lieutenants.	Third Lieutenants	Ensigns.	Cornets.	Quarter-Mr Serjts	Serjeants.	Corporals.	Musicians	Artificers.	Sword Masters.	Riding Masters.	Farriers.	Saddlers.	Blacksmiths	Drivers	Privates	Aggregate.
Light Artillery	1	1	1	1	..	.	..	5	4	2	8	.	.	1	1	.	12	58	95
Dragoons	1	1	1			1	..	5	8	2	.	1	1	1	1	1	..	96	121
Corps of Artillery	1	1	2		..	..	1	5	8	4	.	.	.	..	..	.	..	100	123
Infantry	1	1	2		1		..	5	4	2	..	..	..	..	..	..	..	90	106
Riflemen	1	1	2		1	.	..	5	4	2	..	..	..	..	..	..	..	90	106

Two regiments formed a brigade, commanded by a brigadier-general, to whom were attached one aid-de-camp and one brigade-major. Two brigades formed a division, commanded by a major-general, with two aids-de-camp; and when he commanded an army, one adjutant-general, one inspector-general, one quarter-master general, two assistant adjutants-general, two assistant inspectors-general, one deputy quarter-master general and four assistants, one topographical engineer and one-

was still used by a few corps of light cavalry; there were at the beginning of the last war, light lancers in the army of the Emperor of Germany. All military writers have concurred in the suppression of the lance, and in the little efficacy of fire arms for cavalry, excepting the dragoon musket, used when this corps does infantry service.

Weapons of the infantry, and opinions of many Generals on the suppression of the pike.

Having shown that since the invention of fire arms, the use of small arms and their combination with the pike have produced successive changes in the armament of infantry, we will proceed to state a few opinions on these changes. In the time of Turenne, fire arms were already greatly multiplied in the bat-

assistant; beside a chief of each department, as many assistants might be allowed as there were brigades in each separate army.

This was the largest *regular* force ever raised by the United States. The General Staff consisted at the same time of eight major-generals, sixteen brigadier-generals, one adjutant and inspector-general (attached to the War Department), eight adjutants-general, sixteen assistant adjutants-general, eight inspectors-general, sixteen assistant inspectors-general, five topographical engineers and five assistants, one quarter-master general (with the rank of brigadier-general), seven quarter-masters general (colonels), twelve deputy quarter-masters general with 30 assistants, besides a Medical and Hospital Staff, Commissary's and Pay Departments, &c.

The highest rank that has existed in the American army was that of *General;* this was the rank that General Washington held while commanding the armies of the revolution. After his retirement from the Presidency, and on the expectation of a war with France in 1798, this great man was again called to command the armies of his country with the title and rank of Lieutenant-General.

The ranks of General and Lieutenant-General have not since been revived, from perhaps a grateful reverence for the memory of the Father of his Country, of the man who was "first in war, first in peace, and first in the hearts of his countrymen."

Thus the total force on the War Establishment at the peace of 1815, was 62,448 men; at least such was the number provided for by law. There is reason to believe that the half of this force was never raised; for the Northern Army, including all its divisions, never exceeded 14,000 men; a force amply sufficient to have marched to the gates of Quebec in the summer of 1814.

After the peace the army was reduced to 10,000 rank and file, formed into a corps of engineers (as described above), one regiment of horse or light artillery, 32 companies of artillery (constituting the artillery corps), eight regiments of infantry, and one regiment of ridemen. This enumeration is exclusive of the Military Academy, consisting of 250 cadets and professors and teachers.

TRANSLATOR.

talions, the number of matchlocks and muskets being to the number of pikes and halberds, as 2 to 3. In 1703 and 1704 the pike was totally suppressed, and all the infantry were uniformly armed with the musket and socket bayonet.

This important change in the weapons of the infantry was the rapid consequence of the observations and reasonings of many distinguished Generals, who marking the principles on which the science should be based, saw the great advantages of possessing a single weapon fitted for all kinds of ground and all the exigencies of attack and defence. About 1689 Marshal d'Asfeld became convinced that the musket and the bayonet were superior to all other weapons ; and the Minister, Louvois, concurred in all the reasons alleged in favour of the change. About the same time (1691) Marshal Luxembourg advocated the opinion of Marshal d'Asfeld, and declared that at the battle of Fleurus in 1690, he remarked that the Dutch battalions that were armed with the pike, were much easier beaten than the Germans who used the matchlock.

In the following years Marshal Catinat, conducting the war against the Barbets or people of the Alps, ordered all the pikes in his army to be suppressed, and the soldiers to be armed with muskets. And in 1703 Marshal Vauban, reasoning from the principles and deductions of fortification, and perhaps more like an engineer than a General, proposed the total suppression of the pike ; he was warmly opposed by Marshal Montesquiou, and the question was discussed with an ability and learning worthy of these great men. After weighing all the opinions of the famous Generals who took part in the discussion, Louis XIV ordained that all the infantry should be armed with the musket and bayonet.

Proposition of of Marshal Vauban, and the suppression of the pike in 1703.

Military writers, celebrated for their works and great experience, have been divided on the question of abolishing the pike. Folard, carried away by the spirit of theory, is the champion of the pike, with which he bristles his columns of attack, and, as he imagines, thereby secures to them the victory. Infantry thus armed, he considers capable of repelling all the assaults of cavalry, and on these principles constitutes his particular and general orders of battle.

Puysègur considers the musket and bayonet as the most ex-

cellent of weapons, and approves of the suppression of the pike.

Lloyd differs from these writers, and thinks the infantry badly armed to attack cavalry, or defend itself from their assaults: he is of opinion that the musket ought to be shortened, and that the bayonet should be a lance 13 decimètres (4 feet 5 inches) long, and capable of being used separately to great advantage. According to his system, $\frac{3}{4}$ of the infantry should be equipped with the musket and lance, and $\frac{1}{4}$ with the long pike, a sword, and a pair of pistols. This armament bears a great similitude to that which existed in the days of Turenne.

We do not agree with Lloyd in arming one fourth part of the infantry with pikes; such a reduction of fire would under many circumstances be productive of great disadvantages. We think, however, that it would be a positive improvement to give to one half the infantry bayonets a little longer and stronger, and to the other half the lance proposed by Lloyd.

The general opinion at present is in favour of the musket and bayonet, and it is generally believed that the pike was suppressed for the best reasons; these reasons have been strengthened since the great increase and improvement of artillery, whose powers have so decisive an influence upon all branches of war.

Important observation on the fire of musketry; and general principle.

Nevertheless it must be observed, that the musket, from the delicacy of its construction, the care that it requires, and the uncertainty of its effects, is a missile not well adapted for field operations. In long contested actions its powers are in a decreasing ratio; and it has been remarked that the first vollies, when well regulated, alone produce sensible effects, and after which the bayonet and the sword may charge without sustaining any great losses*.

* There can be no doubt of the excellence and superiority of the musket and bayonet. In the war of 1812 an attempt was made by the late Brigadier General Pike to introduce the *pike* in the third ranks of the infantry, the soldiers of which were also armed with short muskets. The 15th regiment, and I believe another, were equipped and formed in this manner; a few months sufficed to show how vain this affectation of improvement was.

Were it possible that the pike could be used to advantage, the United States of America is the last country of the earth where these advantages

Notwithstanding this, and the opinions of many writers, it is certain that the missive weapons of the moderns are infinitely superior to those of the ancients; and it is not surprising that their invention and improvement have produced such great changes in war and military science.

(See "*La Milice Française*," by Daniel).

could be obtained. The woody, broken, and intersected nature of the country, and the habits of the people, accustomed to the use of fire arms from their earliest boyhood, are circumstances so favourable to the use and excellent effect of musketry, that it is absolutely ridiculous to talk of the pike.

The improvement of musketry fires is a subject of the greatest importance, and to which the American officers should devote their utmost attention. They will be convinced that there is great room for improvement when they learn, that, according to Guibert, not more than one shot out of 240 to 250 takes effect in the general engagements of European troops. Doubtless this prodigious waste of fire is the consequence of their soldiers not being accustomed to the use of fire arms from their childhood. I have often heard that great and distinguished man, Adjutant-General Cumming, whose retirement from service is lamented by the army and regretted by the government, and whose future illustration it does not require the spirit of prophecy to foresee, declare that it was possible to so discipline and improve the fire of American troops, that two or three rounds should annihilate any European line.

We have a practical confirmation of this opinion in the battle of Chippewa (1814), where the ratio of effect of our fire, was one shot out of thirty, or *eight times* the ratio of European musketry! Tis true that the number of combatants was small; the force commanded by General Scott was 1200 strong; the British corps consisted of 1800 men. The battle was fought at mid-day, on a perfect plane, and was a fair trial of skill and valour; the result was such as will always be obtained by American troops when ably commanded.

TRANSLATOR.

CHAPTER V.

General Principles of the Orders of Battle proper for the different arms; Orders of Battle of the Ancients and Moderns; Field Artillery; grand and minute Tactics.

26 Form and disposition of a force combating in order, and of the front, flanks, and rear.

26. TROOPS organized and armed to fight in order, can never attain the degree of power of which they are (4 and 5) susceptible, but by forming into one body capable of assailing and defending, and all whose elements act simultaneously. This body should, by means of a simple and methodical formation, be able at pleasure to unite and decompose its elements.

In all ages the means of attaining this power has been, to form the men into equal files, their leaders ranged next to each other on a straight line. This disposition enables the mass to decompose itself into several parallel ranks, and produces a rectangular figure of greater or less length and depth. The side facing the enemy is called the *front*, and the opposite is the *rear*; the other two are called the *flanks*, and sometimes the *wings*.

Order of battle of a separate corps, light or deep.

This formation of troops, is called the *order of battle*: it is the order of *depth* when the files contain 6 men or more, and is the *light* order when they do not exceed 6, nor are less than 2.

27. General order of battle; of an army; qualities that its elements and corps should possess.

27. The general order of battle of an army varies according to many circumstances, of which we will not at present speak; but when once it is arranged, it is requisite that the whole mass, or some of its parts, have the capacity of moving with the greatest celerity and producing the greatest effect at the moment of conflict. These properties of *celerity* and *force* can only exist in an army or order of battle in proportion as they are inherent in its constituent elements or units of force.

Important deduction.

Hence all troops should possess, 1st, strength; 2d, activity, which produces celerity; and 3d, universal mobility: by this latter quality must be understood a formation adapted to all kinds of ground, and to acting against all species of assailing troops; also, that the troops use their arms to the greatest effect against the enemy.

Truths and rules that should govern in the formation of lines of battle of infantry and cavalry.

Reason and experience demonstrate that a line of infantry of a certain extent and in the light order, can only move very slowly; that in attempting rapid movement it breaks and ex-

hibits great and dangerous undulations, and would be easily pierced through by troops in deeper order, and its separated parts put to the sword or rout. Hence it is that the light order is only proper when the infantry is to make use of its fire and to remain almost stationary, or to shield it as much as possible from the enemy's artillery: therefore, infantry in the light order has neither *force* nor *activity*, but it possesses *mobility**.

Tacticians have found that the deep order or column, the front of which is inconsiderable, is the most favourable for marches; provided that the depth does not exceed 12 to 15 ranks. In rapid marches the 12 first ranks can preserve a dependency of movement; but if we subject to the same rapidity of motion a greater number of ranks, the velocity becomes sensibly diminished. Thus it is evident from the simplest principles of Dynamics, that the column at the moment of the shock acts only with the weight of the first rank; but as this is then pressed onward by all the other ranks, it is obvious that the force of the column most rapidly increases in a very short space of time, and must break and overthrow the feeble lines that are opposed to it. Therefore the column, when formed according to approved principles, possesses *activity*, *mobility*, and strength. But if its dimensions be too large, it loses the two former qualities, and possesses only strength.

Order of battle for cavalry; maxims respecting the charge.

If we examine what passes in a charge of cavalry, we shall find that the whole effect is produced by the shock of the first rank; for all the parts being disunited, they do not press together as in a column of infantry. And as the shock of the first rank depends upon the swiftness of the horse and the sword of his rider, it follows, that in general the order of battle for cavalry should be the *light* or *thin* order. Cavalry of the line therefore must be considered as an *arm of the shock*, to break through any corps that may be in opposition; and we may lay

* The light order or the line, or the order of fire, is the fundamental and primitive order of infantry, and is of the first importance and consideration. The shock or charge, is incidental or secondary.

The front of a battalion should not exceed 140 to 180 files; when it exceeds this number, its stability is endangered, if not destroyed; and the line is constantly exposed to dissolution. The battalions should be always full, and must not be composed of boys and men incapable of sustaining fatigues. *Guibert's General Essay on Tactics.*

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it down as a maxim, *that cavalry, however heavy or firm it may be, must never wait to receive the charge of another body of cavalry, not even of light cavalry;* for the simplest laws of Dynamics show that it must inevitably be overthrown by the velocity of the charging body. Hence the *light* order of two or three ranks, or at the utmost four, is the fittest for cavalry; excepting in particular cases where the order of depth may be used*.

Order of battle for infantry.

The order of battle of infantry, is determined by its armament, the nature of the forces to be vanquished, the ground or topography, and other determining circumstances. If the in-

* At the battle of Prague, the Austrian cavalry was in three lines, and the Prussians in two. If it be dangerous to extend cavalry too much, it is not less so to concentrate them in such a manner as to paralyze one-half of their strength, and to subject them, without the least utility, to the united dangers of fire and of rout. We are therefore justified in concluding, that a formation of cavalry in two lines, is always excellent; and that a *third* line is a violation of the rules of the art; unless the nature of the ground, by preventing the display of an arm that cannot be used every where, requires this formation.

If it be desirable to gain the extremity of the enemy's line, it would seem that in a charge of cavalry in two lines, a reserve formed behind the first line into columns by squadrons, might at the moment of the charge turn the flanks of the enemy, and taking distance while advancing, form in order of battle by a mere conversion of squadrons to the right or left, and thus take the enemy's line in reverse. *Jomini.* Part I. chap. 1. p. 135.

The preceding rules are confirmed by all experience. At the battle of Sohr (in Bohemia, 30th Sept. 1745), the Austrian cavalry were posted in three lines, and so close together, that there was scarcely 20 paces between the lines, behind which there was a precipice. They began by firing their carabines, as was their custom; but before they could draw their swords, the cavalry of the great Frederick was upon them, and forced the first line; the rout of the first line produced that of the second, and the flight of the second brought on the rout of the third; they were part thrown down the precipice, and part thrown back upon their infantry.

When the first line of cavalry is defeated, they should retire to the right and left of the second line, re-form immediately, and if possible in potence forward, or at least gain this position when the second line renews the charge, and thus take the enemy in flank: but the extremity of the potence must be out of the enemy's immediate reach, by being thrown off at a considerable angle from the extreme of his line, or favoured by ground or other circumstances; otherwise he could take the potence itself in flank, as General Zietnen did Nadasty's cavalry at Kollin, and Haddick's at Prague. TRANSLATOR.

fantry is to remain almost stationary and use its missile weapons, then the light order of 2, 3, 4, or 5 ranks deep, is the best; in order to use the greatest quantity of fire, and be shielded as much as possible from that of the enemy. But if the infantry is to be moveable, and to charge with the bayonet to break the enemy, then it should be disposed in deep order or moveable columns. Hence the order of battle of infantry ought to be alternately light, and deep.

Units of force or battalions and squadrons, in relation to orders of battle.

We now perceive the necessity and relation of battalions and squadrons, or units of force, to orders of battle; these should not exceed a certain number of combatants, and should be organized and disciplined to assume rapidly the light order, from that form the order of depth, and display from the latter into the former. Experience has established the proper standard for a battalion to be from 500 to 1000 combatants; and for a squadron 150 to 200. The lesser standard does not possess sufficient firmness; and the greater impedes the celerity and promptitude of marches and manœuvres. By means of these units of force or elements of the line, the order of battle is formed, and modified or changed, according to circumstances and the directions of the General commanding.

28. Orders of battle of cavalry and infantry among the Greeks. (See The Commentaries of Polybius, "La Milice Française," The Encyclopædia, &c.)

28. Among the Greeks, cavalry was first formed in Thessaly, long after the Trojan war; this species of force never existed among these people or the Macedonians, nor in the armies of Alexander, in any considerable numbers. For a long time the use of cavalry was confined to skirmishing; and it was not till after many experiments that they fought in close and regular order. The Rhomboidal order of battle, and the wedge or redan, both formed of ranks or files, or both, were at first much used by the ancients; but as the shock was only from the leading four horses, the velocity was suddenly lost, and the effect incomparably less than that of the simple rectangular form 4 or 6 deep. Accordingly this latter formation was soon adopted, not only by the Persians and Sicilians, but by all the nations of Greece that cultivated the military art. The cavalry of the Greeks and Persians, and of other nations, was divided into isles or squadrons of about 64 combatants, commanded by an Islarch, whose station was on the apex in the wedge or rhomboid. The wedge was often used by Philip of Macedon. Alexander constantly employed the rectangular formation of various depths, and greatly increased the strength of the isle or

squadron, which in the elite cavalry he made 225 strong. The isle was the unit of force; eight isles constituted an hipparchy or corps of 512 combatants, called among the Romans "*Ala*" or wing, and was what we call *regiment*. Eight hipparchies formed one *epitagme* or body of 4096 men, and which we now designate *reserve*. The armies of Greece and Rome never had a greater force of cavalry than one *epitagme*.

Orders of battle of the Greek and Roman, Persian and Macedonian infantry; the phalanx.

The infantry of the Greeks, Persians, &c. constituted the main body of their armies; the cavalry were few in numbers, and only an auxiliary arm. The order of battle of the Greek and Macedonian infantry, was the order of depth, or *phalanx*; and without entering into the details of its formation and division, we will merely describe it as consisting of files closely united together to form ranks. Two files formed a division, and the front could be more or less increased or diminished in proportion to the number of divisions: each file had its file-leader and file-closer. The depth of the phalanx varied in time among different nations, and according to the tactics of the General. It does not appear that its depth was ever less than eight to the file; this was a modification of a primitive and deeper order. The greatest tacticians made the primitive or habitual order 16 deep, as most favourable to doubling and displaying the phalanx. Thus its form was rectangular, cut in the centre by an axis parallel to the front, and by others perpendicular, marking the divisions composed of two files each. By this formation the phalanx could speedily be formed into a depth of 32, or displayed in files of 8 men: any formation below this latter number, was regarded by the ancients as destitute of firmness and stability. The soldiers of the phalanx were armed with the sarissa or pike, the straight sword, and the buckler, and were called *oplitæ*. Those of the light infantry were styled *psilæ*, and their number was generally about one half of the *oplitæ*: they were formed eight deep, on a front equal to that of the phalanx.

Composition of the elementary and of the *complete* phalanx.

The elementary phalanx consisted of 4,096 men, in 128 divisions; and the re-union of 4 of these formed the *complete phalanx*. This infantry of the line 16,384 strong, was accompanied by 8,192 *psilæ* and by 4,096 cavalry.

Extent of front of the phalanx.

The phalanx in order of battle had three different formations; 1st, the *open* order of files; 2d, the close order; and 3d, the locked files. The first was when the *psilæ* were in

front and about retiring to the rear of the phalanx ; the second was for the onset ; and the third disposition was when they locked their bucklers to sustain the shock of the charge. The extent of front of the elementary phalanx was, according to these three cases, 480, 240, or 120 mètres (540, 270, or 135 yards) long : in this latter order, each soldier occupied only 17 inches and 1 line (a little more than 18 inches Eng)

General order of battle of the Greeks.

Among the Greeks the *psilæ* always commenced the action on the front of the phalanx, and then retired to sustain the latter with their missiles. The cavalry were stationed on the flanks to oppose the enemy's horse ; and often part of the cavalry were kept in reserve behind the phalanx, to penetrate through the openings made in the hostile body. This order, however, varied according to the genius of the General, the circumstances of the ground, and the dispositions of the enemy.

Length of the sarissa or pike.

The sarissa or pike, varied much in its length : the longest were 28 feet 6 inches (30½ feet) ; but the best and commonest length was 14 cubits or 19 feet 11 inches (about 22½ feet). The six first ranks bristled the front of the phalanx with their charged pikes, whilst the remaining ten ranks, carrying their pikes, pressed forward and augmented the weight of the shock.

Analysis of the power of the phalanx as an order of battle.

The powers of the phalanx, elementary or complete, are obvious ; it possessed from pressure an eminent degree of force in the shock, but was too massive or heavy for even a moderate celerity of movement. Obliged to close its divisions in attack, there was no longer room for the *psilæ* to act with confidence on its front, or for the cavalry to second and combine their attack with its operations ; and when the depth was doubled, these defects were more palpable, and the phalanx became merely a resisting body, incapable of the activity necessary in combat. Moreover, the phalanx was only fitted for plain countries ; and if the Macedonians vanquished the Persians, it was because these fought on the plains. Therefore it is evident, that the phalanx is destitute of *celerity* and *universal mobility ;* and is consequently not a good order of battle.

29. Orders of battle of cavalry and infantry among the Romans ; the legion considered as the element of an army (See Folard, Puységur, Daniel, the Encyclopædia, &c)

29. From the birth of the republic, Rome had cavalry in her armies ; but till the decline of the empire, infantry constituted the main body ; cavalry being only an auxiliary, and in the proportion of 1 to 10. The first legion that was raised, consisted of 3,000 infantry and 300 cavalry ; and when afterwards the strength of the legion was increased to 4,500 men, the propor-

tion of cavalry was still 300; but when it was afterwards augmented to 6,000 men, 5 to 600 of them were cavalry*.

Order of the Roman cavalry: the turma an unit of force.

The legionary cavalry, however great their numbers, were divided into 10 *turmæ* or troops, composed of from 20 to 60 horsemen: the turma in battle was 4 or 5 deep: and all the turmæ were ranged upon one another, or formed several parallel ranks in rear of each other.

Composition of the legionary infantry: the cohort an unit of force.

The legion was a corps very similar to what we now call a complete division, combining in itself all the constituent elements of an army, and was composed of, viz. 1st, cavalry: 2d, heavy infantry: 3d, velites or light infantry. The proportions of these varied with the numerical strength of the legion, which as a mean, we will estimate at 4,500 men, of whom 300 were cavalry: this was the force of the legion anterior to and during the time of Cæsar. The infantry of the legion was divided into ten coborts, the force of which varied with that of the legion: the cohort was an unit of force of the legionary infantry, and answers to battalion.

Order of battle of the legion: the 3 modifications that it underwent.

In the early days of the republic, the order of battle of the legion was analogous to that of the Grecian phalanx: but as the principal weapon of the soldier was the hasta and straight sword (see art. 6), the depth of the file was diminished to ten, and even to eight men. Small intervals were left between the coborts for the velites to retire through, and the soldiery were divided into *five* classes with different weapons. The number of classes afterwards was reduced to *four*, consisting of, 1st, the *velites* or light armed soldiers, armed with the sling and the javelin: 2d, the *hasta*, who, originally armed with the hasta or spear, performed the service of velites; but they were afterwards equipped with the pilum and straight sword, to combat in line: 3d, the *principes*, armed from head to foot, wielding the the straight sword and constituting the strength of the

The 2d order of battle in 3 lines.

* The Romans to perfect their cavalry took away their bridles, that nothing might stop their impetuous career. When the equestrian order dismounted, they were the most formidable infantry, and often decided the fate of battles.

"They exerted every means to obtain Numidian horses, Cretan archers, and Balearean slingers, and Rhodian vessels. Indeed no nation "ever prepared for war with more caution, nor made it with more "daring."—*Montesquieu's Grandeur et Decadence des Romains. Polybius.*

TRANSLATOR.

line ; 4th, the *triari*, armed with heavy javelins or pilums, and with larger bucklers than the other classes.

The legion was then composed of four species of troops, velites, *hastæ*, *princes*, and *triarii;* the number of each being determined according to the strength of the legion.—The formation of the cohort was in the same proportion. If we suppose the legion to consist of 4,500 men, there would then be 300 *cavalry*, 1280 *hastæ*, 1280 *princes*, 600 *triarii*, and 1040 *velites;* and this was the general formation down to the reign of Tarquin. The phalanx order was then abandoned, and was succeeded by one of three lines. The first line composed of the *hastæ* of each cohort, 8 men deep, leaving between the cohorts small intervals for the velites ; the second line consisted of the *princes*, likewise 8 deep, having their centre opposite the intervals of the first line ; and the third line or *triarii*, only 6 deep, so as to equal in front the two first lines. This latter was the reserve, composed of the oldest and most experienced soldiers*. The cavalry posted on the flanks, completed the order of battle.

Extent of the legionary front in battle.

Supposing that the legionary soldier occupied a front of only one mètre (3 feet 4 inches), and that the intervals between the cohorts were equal to one half their front; the whole front of the legion, including the cavalry, would be 1400 mètres or 1530 yards. Thus an army of four legions (18,000

* Each Roman trusted much in his own strength and skill, and not in the multitude; and as their discipline was perfect, it seldom occurred that a whole Roman army was routed or broken, or that the enemy escaped being thrown into disorder.

Their chief attention was to discover in what particular the enemy might be superior to them; and to remedy this. They no sooner discovered institutions and weapons superior to their own, than they adopted them ; they adopted the large Sabine buckler, and the Spanish short stabbing sword: thus maintaining their superiority in every thing, and laying the foundations of their greatness. They learned from Pyrrhus the use of elephants, and to intrench and fortify their camps.

It is remarkable, that the nations vanquished by the Romans never inquired into the causes of their repeated defeats ; but persevered in the use of their weapons and institutions to the last moment of their political existence. What weapons could be worse than the curved cutting sword and small buckler of the Gauls?—*Montesquieu, Grandeur et Decadence des Romains.* TRANSLATOR.

men), would present a line of battle of about 5,600 mètres (6,250 yards) or upwards of one league.

Third order of battle of the legion: the cohort an unit of force.

The order of battle in three lines, formed of the four classes of soldiers in the legion and cohort, existed without any important alterations for nearly 500 years and to the days of Marius, who abolished the distinction of *velites*, *hastæ*, *principes* and *triarii*, and gave to all the legion the same weapons*. Their offensive arms were now, the pilum, and straight sword; the light troops ceased to compose the legion. These were auxiliaries to it, generally strangers and allies serving under the standard of the republic. The legion was divided into cohorts, which was considered as an unit of force, and consisted of 480 men: the legion of 10 cohorts contained 4,800 legionaries, 400 cavalry, and upwards of 1,000 light armed soldiers.

Pursuant to this formation, the last order of battle adopted by the legion was of *two* lines, both formed of cohorts 8 deep, with sufficient intervals for the light troops to pass through. Sometimes the cohorts of the second line faced the openings in the first, and at others covered the cohorts on their front. Latterly all the cohorts were often drawn up on one line to show a greater front, and supported by a heavy reserve in second line. The cavalry posted on the flanks completed the order.

Analysis of the order of battle of the legion.

The legionary line of battle just described, was much superior to that of the Grecian phalanx. The legion being only 8 deep, had sufficient force to break through the enemy, and being less cumbrously equipped, its attack was more prompt and violent. Consequently the legion had strength and celerity, and greater mobility than the phalanx; and in this order the greatest number of combatants acted against the enemy. According to the opinions of Polybius, Folard, Puysègur, Turpin,

* The innovations of Caius Marius upon the constitution and military institutions of Rome, by suffering the nobles and equestrian order to serve by mercenary substitutes; thus extinguishing the military virtues of those who had the greatest interest in the safety of the republic, and filling the legions with slaves and mercenaries, have by all historians been regarded as one of the most powerful causes of the decline and fall of the republic. When the rich and the noble commit the sword to the enfranchised slave and mercenary soldier, what else can be expected than the usurpation of a government, and the plunder of a country?—(See *Gibbon's Decline and Fall. Ferguson's Roman Republic:* and *Montesquieu's Grandeur et Decadence.* TRANSLATOR.

Montècuculi, Lloyd, and others, it was the most perfect order of battle that has ever existed.

Consequences of the preceding.

It follows from this brief review of the orders of battle of the ancients, that the formation of their troops was adapted to their weapons; that the phalanx was inferior to the legion; and that both were defective in not leaving sufficient intervals between their units of force for the light troops and cavalry to combine their attack with that of the heavy infantry*.

* "The Roman armies were not very large: their discipline and subsistence was therefore the easier maintained and provided for; and the admirable highways that they constructed, enabled them to move with rapidity and arrive unexpectedly. Witness the fate of Asdrubal and of Viriathus."

"Their armies enjoyed health in all countries and climes, whilst modern armies melt away in one or two campaigns; and the reason of the difference is—that the Romans never relaxed from labour and exercise; whilst the moderns, suddenly roused from a state of idleness and luxury to great exertion, and then relapsing, sink beneath the violence of such irregular and opposite modes of life. The Roman armies marched 20 and 24 miles in 5 hours at the military pace, and with a burthen of upwards of 60 pounds.

"We may judge of the severity of their discipline by Manlius putting his own son to death for fighting a single combat against orders; and by the toils and privations to which Scipio Æmilius, Metellus, Marius, and Sylla, condemned their armies.

"Whenever they pitched their camp, they immediately intrenched it; and by exercising their troops in time of peace with weapons and armour of double the common weight, and imposing upon them stupendous labours, they made war a season of meditation, and peace the period of exercise. Marius and Pompey are praised for continuing in their old age the exercises of a legionary soldier."—*Montesquieu, Grandeur et Decadence.* See also *Gibbon's Decline and Fall:* and *Polybius.*

Josephus says, that there was not much difference between the common burthen of a Roman soldier, and that of a pack horse; and Cicero says that they carried more than 15 days provisions, their clothing and equipments, and implements for fortifying; and that their weapons no more incommoded them than their hands and arms.

Gibbon says—"Nor was the legion destitute of what, in modern language, would be styled a train of artillery. It consisted in ten military engines of the largest, and fifty-five of a smaller size; but all of which, either in an oblique or horizontal manner, discharged stones and darts with irresistible violence."——"And yet so sensible were the Romans of the imperfection of valour without skill and practice, that in their language the name of an army was borrowed from the word which signified exercise. Military exercises were the important and unremitted

30 Orders of battle, general and particular, since the establishment of the French monarchy.

30. The Gauls by long wars with the Romans learned from them the art of war, and to form and discipline their armies; and the nations of the North that invaded Gaul, acquired some military knowledge from this latter people. The Franks, after their conquests, and under the immediate government of their kings, introduced into their orders of battle system and regularity; they had no light troops, and but very few cavalry We have already stated (art. 6) that their arms were the javelin or angon, the double edged battle-axe, the straight sword*, and the buckler. Their order of battle was deep (*profond*), formed of many battalions, and, like those of the Romans, 8 to 10 deep. The battalions were disposed according to the plan of the General; sometimes in many double lines, and at others forming the wedge. To give some idea of the mode of fighting in those days, we will describe the celebrated battle of Casilinum, fought on the banks of a stream of this name in Italy, in the year 553.

Orders of battle of the first French; battle of Casilinum in Italy, between the Franks and Romans, in 553. (See PLATE I, & its explanatory table.)

The army of the Franks consisted of 30,000 foot, commanded by Buccelin, one of the Generals of Theobald. The Roman or Emperor Justinian's army, was 18,000 strong, including about 2,000 cavalry, and was commanded by Narses. The plan annexed exhibits the army of the Franks drawn up like a phalanx, flanked by two wings, giving it the form of the wedge (*tête de porc*); the design was to surround the Roman army, whilst at the same time the head of the wedge broke through its centre.

Narses, although abandoned by the Heruli†, formed his forces

'object of their discipline. The recruits and young soldiers were con-
"stantly trained both in the morning and in the evening, nor was age nor
'knowledge allowed to excuse the veterans from the daily repetition of
"what they had completely learnt." TRANSLATOR.

* Montesquieu, in his "*Grandeur et Decadence des Romains*," says that the Gaulish sword was curved and cutting. Perhaps a difference between the arms of ancient Gaul, and of Gaul under the Romans and Franks, is the cause of this seeming difference. TRANSLATOR.

† Buccelin's army was originally 75,000 strong, but on entering Italy the year before, he divided it into two corps, one of which he gave to his brother Lothaire, who towards winter retired beyond the Po with the plunder and spoils of Italy, of which alone he was ambitious.

The army of Buccelin was composed equally of Franks and Alemanni, and he invaded Italy to restore the empire of the Goths and place himself or Aligern, the heir of the slaughtered Totila, on the Gothic throne. Had his

like a legion; and by a manœuvre worthy of a great General, detached unperceived by Buccelin two corps of cavalry on his flanks. After the first shock of the Franks, his cavalry surrounded and cut them to pieces; nearly their whole army pe-

brother Lothaire been as eager for fame as he was for plunder, the eunuch Narses might have felt the sword of a conqueror, and the pragmatic edicts of Justinian never been heard of in Italy.

The eunuch Narses, the successor of the renowned Belisarius, improved the winter in disciplining his forces; and at the opening of spring marched against the barbarians, who had taken quarters in Calabria. Buccelin slowly moved north to Capua, and took post on the Casilinum, his right covered by the Vulturnus and his camp fortified by "a rampart of sharp "stakes and a circle of wagons whose wheels were buried in the earth," and where he expected the return of Lothaire, "ignorant that this chief "and his army had been swept away by a strange disease on the banks of "the Lake of Benacus" (*now Lago di Garda*), "between Trent and Verona." Narses approached the posts and camp of Buccelin, which he invested, and cut off from communication and supplies.

"On the morning of the important day, when the ranks were already "formed, a servant, for some trivial fault, was killed by his master, one "of the leaders of the Heruli. The justice or passion of Narses was awa-"kened: he summoned the offender to his presence, and without listening "to his excuses, gave the signal to the minister of death. If the cruel "master had not infringed the laws of his nation, this arbitrary execution "was not less unjust than it appears to have been imprudent. The Heruli "felt the indignity, and they halted. But the Roman general without "soothing their rage or expecting their resolution, called aloud as the "trumpets sounded, that unless they hastened to occupy their place, they "would lose the honour of the victory." The battle then commenced in the manner above described.

"The flower of the Roman archers, on horseback and in complete ar-"mour, skirmished without peril round this immoveable phalanx; sup-"plied by active speed the deficiency of numbers, and aimed their arrows "against a crowd of barbarians who instead of a cuirass and a helmet, "were covered by a loose garment of fur or linen. They paused—they "trembled—and their ranks were confounded, and in the decisive mo-"ment the Heruli preferring glory to revenge, charged with rapid vio-"lence the head of the column."

"——— Buccelin and the greatest part of his army perished in the "field of battle, in the waters of the Vulturnus, or by the hands of the "enraged peasants: but it may seem incredible, that a victory which no "more than five of the Alemanni survived, could have been purchased by "the loss of four score Romans."—*Gibbon's Decline and Fall*, chap. xliii.

The imperishable history of the Decline and Fall, states the battle to have been fought in the year 554. TRANSLATOR.

rished in consequence of the misconduct of their General, who had not sufficiently reconnoitred the Roman army. This instance shows, that as early as the year 500 the Franks had some skill in war and in their orders of battle.

Orders of battle from the establishment of knighthood and the feudal system, from the year 700 to 1500. (See *La Milice Française*, page 208.)

We have already remarked (art. 7) the rapid changes made in the French armies by Charlemagne and his successors. The principal force of the armies was cavalry, and on it depended the victory; the militia marched and fought under the banner and command of their barons. We do not know exactly what was the formation or order of each species of force on entering into line; but it is probable that the archers were 3 or 4 deep, that the pikemen were formed like the Roman legion on 8 or 10 ranks, and that the light cavalry fought in squadrons, or skirmished in small troops. As to the gendarmes or knights in complete armour, we know that they fought in one single line, supported by their squires, &c. in the rear.

There was no established mode of forming the general order of battle; this formation was decided by circumstances, the talents of the commander, and often by accident. The chief dependence for victory was upon the strength of the cavalry, which constituted the first line and occupied the most exposed points: the infantry was but an auxiliary arm, forming a second line and displaying on ground where cavalry could not act*.

Progress of the art during 700 years.

From these facts it is evident that for nearly seven centuries the science of war was not known, nor were military operations founded on any rational or methodical system; during this long

* A war of manœuvres is adopted in proportion to the discipline of the enemy and the skill of the general. Until the era of Gustavus Adolphus and the princes of Nassau, the restorers of military science, armies were brought into contact without concert or science or skill, and fought like *mobs*. They were formed in *one* column of three divisions; the first division was called the vanguard, the second was the fighting corps or corps of battle, and the third was the rear guard; a whole day was not sufficient to unfold this deep and complicated mass.

The vanguard, composed of archers and the forlorn hope, commenced the action; then the gendarmerie or nobility advanced to their support; lastly the despicable infantry or commoners followed, to partake of the plunder, or of the rout.

Even at this day the Ottoman armies are not much better.—*See Guibert's General Essay on Tactics.*

TRANSLATOR.

period the tactics and principles of the Romans were forgotten and lost*.

31. Orders of battle from the institution of regular troops, about 1530, to the days of Turenne, Condè, Montècuculi, &c. about 1660.

31. No sooner had the genius and experience of Francis I perceived the necessity of a standing infantry armed and disciplined for attack, than he revived the Roman institutions, and formed legions of pikemen. This heavy infantry was, like the legions of Rome, drawn up 6 or 8 deep, and made part of the general line of battle; and, after the manner of the Romans, when the ground was favourable, constituted the centre; the cavalry being upon the wings. The army was displayed in several lines according to circumstances, having intervals between the corps of the first and second and even of the third line. These openings favoured the retreat of the light troops, and the alternate attacks and retreat of the different lines.

Order of battle of cavalry in *squadrons* in the time of Henry III and IV, 1560.

Towards the close of the reign of Henry II, the order of battle of the cavalry was changed, and the advantages were perceived of combating in squadrons 4 deep: this disposition had

* "Hamilcar was the first general who invented marches on *many* columns: an invention that Hannibal improved, and the Romans copied. It was by campaigns of marches and manœuvres that Fabius saved his country."——"The larger an army, the more numerous must be its columns."—*Guibert's General Essay.*

The order of march and battle of a Roman army is well described by Gibbon: "Whenever the trumpet gave the signal of departure, the camp was almost instantly broken up, and the troops fell into their ranks without delay or confusion. Besides their arms, which the legionaries scarcely considered as an encumbrance, they were laden with their kitchen furniture, the instruments of fortification, and the provision of many days. Under this weight, which would oppress the delicacy of a modern soldier, they were trained by a regular step to advance in six hours near twenty miles. On the appearance of an enemy, they threw aside their baggage, and by easy and rapid evolutions converted the column of march into an order of battle. The slingers and archers skirmished in the front; the auxiliaries formed the first line, and were seconded or sustained by the strength of the legions: the cavalry covered the flanks, and the military engines were placed in the rear."

"Such were the arts of war by which the Roman emperors defended their extensive conquests, and preserved a military spirit, at a time when every other virtue was oppressed by luxury and despotism. The peace establishment of Hadrian and his successors was composed of no less than thirty of these formidable brigades; and most probably formed a standing force of three hundred and seventy-five thousand men."—Vol. I. chap. 1. TRANSLATOR.

certainly greater strength, celerity, and mobility. In the time of Henry IV (art. 14) the lance was laid aside for the sword; and this change of weapons perfected the order of battle of the cavalry. Since this period it has undergone no important alterations, though brought to greater perfection by improvements in minute tactics.

Orders of battle at the period of forming all troops into battalions and squadrons, 1635.

It has been already stated (art. 15) that it was during the reign of Louis XIII that some great Generals conceived the idea of organizing all troops into battalions and squadrons. From that period orders of battle became more regular, and the principles of the Romans, which had been lost for so many ages, began to be propagated throughout Europe. Orders of battle were modified in relation to the weapons, which were (art. 17 and 25) then matchlocks and pikes; and efforts were made to combine the powers of both to the greatest effect. The customary order of battle for infantry, was the oblong of eight ranks; and it is probable that as the pikemen required for attacks great force in the shock, they were formed in columns of 16 to 32 ranks deep. Regular general orders of battle were in two or three parallel lines; the squadrons and battalions in each line separated by intervals equal to their front; those in the second line faced the intervals in the first, and thus formed the quincunx order.

Orders of battle during the times of Turenne, Condè, Montecuculi &c from 1648 (See PLATE II, fig. 1)

Thus we behold the principles of the science unfolding themselves by the light of reason and experience. The brigades of infantry were composed of 2 regiments and of 4 battalions in line, and answered to the Roman legion; and the battalion to the cohort.

Towards the middle of the 17th century, Condè and Turenne, in their first campaigns, formed their battalions on 8 ranks, the pikes in the centre and the matchlocks on their right and left; the grenadier company was on the right. After some time the number of ranks was reduced to six, and at the close of a campaign to 5: in this manner the line of infantry became a mean order of depth.

In the days of Turenne, Condè, and Montècuculi, artillery had not acquired those powers of destruction that it now possesses; and the fire of the infantry was not so efficient as to prevent the contact of troops, and the charge of the bayonet and the sword. The order of depth was therefore the most proper

habitual order of battle to be used by Generals capable of estimating its powers (see art. 27).

Nevertheless it must be admitted that this order, in which *one* third of the men were armed with matchlocks and muskets, and *two* thirds with pikes, was defective in three respects, viz: 1st, in intermingling matchlocks with pikes; 2d, because each company did not form an integral part of the line; and 3d, because the officers stationed on two lines, in front and rear, could not immediately watch over and conduct the movements of their companies.

A more advantageous disposition.

To give to a battalion, armed with the pike and matchlock, an order for attack and defence conformable to the principles we have laid down (art. 25), we would form the platoon or company 6 deep, regarding it as an integral part of the battalion; and, after the manner of the Romans, arm variously its different ranks. Suppose the company to consist of 54 men, or 18 musketeers and 36 pikemen; there would then be 9 combatants in each rank. The two first should be composed of the smallest men, armed with the matchlock and the sword; the remaining four ranks should be pikemen. The first rank of the matchlocks, after having used all their fire, should retire through the small platoon or battalion intervals, and form on the rear rank; and at the moment of the charge, the second rank of matchlocks should rush on sword in hand*. In this order all

* It is probable that these men would not "rush" far, for the charged body would be able to repulse them with great ease; especially as they would have to throw aside their matchlocks or muskets, or if they attempted to sling them, they would be greatly incommoded and disordered by the position of the gun. The broken order into which they would be thrown in attempting to charge, and the extinction of their fires, would afford the cavalry of their adversaries an opportunity of utterly routing and destroying them.

At the battle of Prague (1757), the Austrian right and centre, after repulsing the Prussian line under Marshal Schwerin, pursued them sword in hand; the consequences were—the Prussians rallied, and by a united effort of their cavalry and infantry, broke and routed the whole Austrian force. This charge of the Austrians was one great cause of their losing the day. They took this practice from the janizaries, without reflecting that what might be comparatively good with one species of armament, was vicious when opposed by more perfect weapons.

Such are the dangers of pursuing in disorder, that it has grown into a maxim, to draw your enemy on by a feigned flight; and then

the platoons conducted by their respective officers, and formed one upon another, would compose a battalion in regular order, and conformably to the principles of attack and defence; and the battalion would possess all the mobility, celerity, and strength, required in assailing and repulsing even cavalry.

32. Order of battle of infantry in 1704, epoch of the universal introduction of the musket and bayonet. Effects of artillery on orders of battle.

32. No sooner were the infantry uniformly armed with the musket and socket bayonet, and the powers of artillery begun to be felt in action, than orders of battle were modified by the nature of these arms, and especially by the prodigious effects of artillery, which, while troops were stationary or before they met in the charge, swept the ranks from front to rear with terrible destruction*.

The light order supersedes the mean order of depth.

It was therefore but proper to reduce the depth of the *habitual* order, and increase the extent of the front, in order to use a greater quantity of fire; accordingly from 1703, infantry was formed only four deep, and often towards the close of a campaign in three ranks.

turn upon him with the irresistible fury of a regular and orderly attack. The eventful battle of Hastings (1066), is one among many thousands that may be quoted of the successful application of this rule, which cost Harold his life and crown, and established a new dynasty in England.—*See Jomini: and Hume's History of England.*

TRANSLATOR.

* Our young readers will be able to appreciate the powers of artillery, *when well directed*, from the few following facts:

"At the battle of Zorndorff (1758), one cannon shot mowed down 42 "men of the second regiment of Russian grenadiers."—*Teilke on Field Fortification*, vol. 1. page 146.

"At the battle of Prague, the Prussian regiment of Winterfeld, which "was 1400 strong, lost 1000 men in attacking a battery on the heights "near Kyge, when the king was forcing the opening between the *potence* "and the Austrian left. They continued to advance as if they were at a "review, under showers of grape. The Wreden grenadiers rushed forward to their support, crying, '*Give us room, comrades; ye have done enough for glory!*' These valiant troops met as hard a fate. Yet notwithstanding—the enemy were routed and their positions carried!"—*Jomini.* Part I. chap. ii.

Our own history affords glorious instances of the power of artillery when served with skill and coolness. At the memorable battle of New Orleans (1815), won by General Jackson, the artillery swept with death the British columns from front to rear. The same was the case at Fontenoy.

TRANSLATOR.

The battalions of Turenne in 1660, were 8 deep, exhibiting a front of 86 files (art. 17). The battalion of 1701, formed of 4 ranks, displayed a front of 162 files (art. 18). Therefore the front of the latter, though weaker by 200 men, was nearly double the front of the former.

Comparison of the extent of front of a battalion of Turenne, and a battalion of 1701. (See PLATE II, fig. 3.)

33. At first field artillery consisted of a few very light cannon, following in the train of armies to be placed in position on military sites; and this artillery, more or less moveable, combined its powers with those of other arms. When towards the year 1700 very light 4 pounders were cast, two of them were attached to each battalion; and placed in the intervals, they mingled their fire with that of the infantry. From this period artillery of position has always been distinguished from the artillery attached to battalions; the first included all calibers heavier than 4 pounders.

33. Field artillery; battalion, and position pieces.

Although the practice of attaching artillery to infantry corps for the purpose of fighting regularly in line, appears to be almost sanctioned by time; yet it is nevertheless bad, as experience has often proved. Artillery thus scattered on the whole extent of a front, without regard to ground and circumstances, has seldom any sensible effect, and often in forced retreats produces causes of great disasters: we might cite many striking examples that we have ourselves witnessed. Besides, it weakens the moral strength of the soldiery, impedes the manœuvres, and distracts the attention of the troops from the great object. It is therefore with good reason that this disposition of artillery has been suppressed, and that it has been considered under a new point of view, and brought into direct relation and combination with orders of battle of other arms. We will detail these relations in chapter VII.

Defects of the battalion pieces.

34. We will now describe the present orders of battle of all the modern troops with whose composition and weapons we are acquainted. The *habitual order of battle* for each arm, should be determined by the nature of its weapons, which decide the manner and characteristics of the combat. And according to the nature of the arm, the action should begin with the combat of fire arms, and be terminated by the charge of the sword and the bayonet. Therefore the order of battle should vary, viz.: 1st, it should be the light or order of 3 deep, to give the great-

34. Present orders of battle of the moderns: general features of a battle.

Habitual order of infantry in 3 ranks:

Changes to the deep or order of column. (See PLATE III, fig. 1, 2, and 3.)

est effect to the fire; 2d, the order of battle should then change from the light to the order of depth of 6 to 12 ranks, to attack with the bayonet. (art. 27).

Consequently the *primitive and habitual order of infantry* should be the light order, capable of rapidly forming into depth or column.

Habitual order of cavalry, two ranks (See PLATE III, fig. 4 and 5.)

Many writers, and among others the celebrated Lloyd, are of opinion that cavalry should be formed on three ranks; nevertheless if we duly weigh the maxims and principles already established (art. 27), we will discover that the formation of 2 deep is the best; for the third rank neither increases the force of the shock, nor the celerity of the charge. In this formation, manœuvres are more simple and rapid, and though it extends the front, experience shows that the squadron may charge with velocity and without breaking. It is not long since the order of 2 deep has been adopted; the greater part of Europe still form their cavalry in 3 ranks.

Consideration of artillery in orders of battle; formed into divisions.

We have already said, that the artillery should not be strewed along the front of the line of battle: it should combat in moveable batteries, on chosen positions on the front or flanks of the troops. This service is performed by *divisions* and *half-divisions*. General Gribeauval, the ablest artillery officer that ever appeared, was the first who proposed to organize the artillery service into divisions and half-divisions. The division consisted of 8 pieces (8 *bouches à feu*), forming an unit of force of the arm. Experience has however established the division of six pieces, served by one company, to be the unit of force the best adapted to the composition of armies; and the service of both horse and foot artillery is now by divisions: their duty is to besiege fortresses, and enter into lines of battle.

Battalion, and regiment of 3 field battalions, in habitual order of battle: places of the officers and non-commissioned officers.

The battalion forms its habitual order of battle by the distinct organization of ranks and files; the companies are designated *platoons*, and these are the elements of the battalion, forming upon each other to unite and display promptly the line of battle. In every order of battle, the officers and non-commissioned officers of each platoon should be so stationed in the ranks, as to be able to direct and watch over the soldiers. This mode of fighting soldiers under the immediate eye of their officers, was not formerly practised, not even in the armies of Turenne; it constitutes a rule or maxim not to be deviated from.

The battalion forms its order of battle from the right to left, by ranks of platoons; the grenadiers, when with the battalion, are the first company on the right; and there are 8 platoons exclusive of the grenadiers. The platoon is divided into two sections, and the section into four squads; the squad is the last sub-division and is next to the files, and is commanded by a corporal. The union of two platoons, counting from right to left, forms a division; and two divisions make a demi-battalion. Hence the battalion in its order of battle is divided into 2 demi-battalions, 4 divisions, 8 platoons, 16 sections, and 64 squads.

The battalion divided into demi-battalions, divisions, sections, and squads. (See PLATE III.)

(Plate No. III, figures 1 and 2, designates sufficiently the stations of the officers and non-commissioned officers.)

Regiments composed of 3 field battalions form in line from right to left, according to the rank of the battalions, which are separated by intervals of about 20 mètres (about 67 feet Eng). Brigades, consisting of 2 regiments, enter into line in the same manner, by rank of regiment from the right: the regimental intervals are 30 mètres (100 feet); the intervals between brigades are from 30 to 40 mètres (100 to 135 feet). A division of infantry consists of 2 brigades or 4 regiments, or 12 battalions.

Order of battle of regiments, brigades, and divisions of infantry.

The squadron forms its line on the same principles as the battalion; the company constituting a *division*: the division is divided into *two platoons*, and the platoon into *two sections*: the section is the last sub-division to arrive at the formation of files. Thus the squadron contains 2 *divisions*, 4 *platoons*, and 8 *sections*. Plate III exhibits the stations of the officers and non-commissioned officers.

Order of battle of the squadron, regiment, and brigade of cavalry: of the division, platoon, and section in squadrons. (See PLATE III, fig. 4 and 5.)

The order of battle of the regiment is from right to left by rank of squadrons; the squadron intervals being 6 mètres (20 feet). Brigades of cavalry form in the same manner, by rank of regiments. The intervals between regiments are 10 to 12 mètres (33½ to 40 feet), and between brigades 15 to 20 mètres (50 to 67 feet).

It follows from the preceding data, that the formation of a combined order of battle is rapid and easy when its component elements form their separate orders with celerity and despatch.

Formation of a general or combined order of battle.

35. That *part* of war which relates to the formation of orders of battle, and to the conduct of troops in combat, is called *tactics*; it is the art of manœuvring troops and putting them in

35. Of that part of tactics comprehending the marches, manœuvres, exercises, and evolutions of troops, & the use of their arms

motion; and regards in general, all things directly relating to combats and battles.

Marches in general.

Marches are founded on the *cadenced step*, by which the elements of units of force move with greater or less rapidity without breaking or disuniting. The object of all movements is to pass from the order of march to the order of battle, or from the latter to the former*.

Order of march of the column at full distance, right or left in front. (See PLATE III, fig. 6 and 7.)

The order of march for forming orders of battle, is necessarily that of *the column at full distance*, formed by placing all the subdivisions of the line in the rear of one another and at distances equal to the front of the leading subdivision; by this disposition the depth of the column equals the front of the line of battle, less one subdivision†. Marches are also executed by defiling, or causing the ranks to move on parallel lines, &c. And whether a march be in column at full distance, or by defiling, it may be with the right *or left* in front, as circumstances may require.

The several kinds of steps.

There are two kinds of steps:

1st. *The direct step*, by which troops move perpendicularly to the front in *common time*, *quick time*, or *double quick time*. The common time is 76 steps to a minute, the quick time 100, and the *double quick time* 200‡.

* "The movements of an army are *two fold*—to march, or to fight: "by them a country is invaded or defended, orders of battle formed. "countries occupied, and advantages gained.

"An army marching in one column, is embarrassed and fatigued; its "flanks and convoys are exposed; and it is exposed to be defeated before "the *main body* can come into action. In short, one column is the off- "spring of stupidity, cowardice, and ignorance."—*Guibert's Essay.*

TRANSLATOR.

† When the enemy are to be deceived in relation to the strength of a column of manœuvre, the distances between its platoons or divisions will be doubled or tripled, if you wish to exaggerate its strength; and reduced one half or one third, if you wish to make it appear a small column. When marches are made in front and view of the enemy these strategic ideas may be often applied with success, and the weightiest blow struck where the enemy expected only the lightest. *See Guibert, on Marches.*

TRANSLATOR.

‡ By the infantry regulations of the American army—"the length of "the ordinary step shall be 28 inches from heel to heel, and ninety of these "paces shall be taken in a minute."

The *oblique* step—"This step will be in common time, ninety steps be- "ing taken in a minute."

2d. *The oblique step*, to execute a movement oblique to the front, always in common time, or 76 to the minute.

Advantages of the oblique step.

Formerly, all movements in manœuvres were executed by the direct step on lines alternately perpendicular to each other; and this is still common among many European nations. The oblique step has however very great advantages for the two arms, enabling them to pass rapidly and in the shortest possible time from the order of march to the habitual order of battle, and from this again into column; and to execute manœuvres in the presence of the enemy, which would by any other means be impossible: and it is remarkable that these advantages are obtained without exposing a flank to the enemy.

Pace of cavalry.

Cavalry has three paces, the *walk*, the *trot*, and the *gallop*. The swiftness of the walk is 100 mètres or 55 toises (110 yards) in a minute: that of the trot is 200 mètres or 110 toises (220 yards) per minute: and that of the gallop, about 320 mètres or 170 toises (353 yards).

Established facts respecting the pace of horses.

It is believed that a horse passes over 85 centimètres (about 2 feet 9 inches) of ground at each step on the walk or common time; at the trot step 120 centimètres (about 4 feet); and on the gallop, 390 centimètres or about 13 English feet.

It follows, that a horse on the walk takes 113 to 124 steps, on a trot 164 to 180, and on a gallop 96 to 102 steps, in a minute.

Marches in manœuvres and evolutions for attacking and defending.

All manœuvres and evolutions of troops and *corps d'armée*, are executed by marches; by these all the dispositions for attack or defence are made. All attacking bodies should rapidly display before the enemy from the order of march into the order of battle; and from this latter into the order of depth, to quickly attack with the bayonet and sword.

Troops acting on the defensive are exposed to be attacked on four sides, in front, on both flanks, and in rear; they should consequently be able to make head against an enemy on all these faces, and sometimes on all at once.

The quick step or "*quick time*," length the same as common step, and 120 steps in a minute.

"In the charge, and in all circumstances requiring great celerity "of movement, quick time *may* be carried as far as 140 steps in a mi- "nute."—*See the Rules and Regulations.*

TRANSLATOR.

Principles upon which are founded the manœuvres and evolutions. (See the Regulations of 1791, and Puységur, Turpin, &c.*)

By manœuvres of cavalry and infantry are understood; 1st, the manœuvres of the battalion and squadron; 2d, the evolutions of the line.

All manœuvres may be reduced to forming rapidly the battalion or squadron in the habitual order of battle, and passing from this primitive disposition to orders of march, of attack, and of defence; and from these to again form in the primitive order of battle.

Formation of the habitual order.

The formation of the primitive or habitual order of battle, is easily effected by means of the subdivisions of battalions and squadrons in line; they are in the infantry as we have already said (art. 34), demi-battalions, divisions, platoons, sections, and squads; and in the cavalry, divisions, platoons, and sections: all posted from right to left.

Formation of the order of depth or column.

The column is of two kinds, at full distance, and the close column: both having for front a subdivision of the habitual order of battle; that is, a division, platoon, or section.

The column at *full distance*.

The column at full distance is merely used in marches to attack or defend, and is generally a platoon in front.

The *close* column.

The close column differs only from the open in this, that all the sub-divisions close upon each other and form a solid body to break through the enemy, force an intrenchment, or resist the assaults of cavalry. The close column is generally a demi-battalion or division in front, or 6 or 12 ranks deep; its form much resembles that of the Roman legion, being the most admirable disposition for daring and active troops. Both columns are formed much in the same way, by the sub-divisions filing to the right or left in rear of that which is to be in front.

Reflections on the grenadier platoons in manœuvres.

If the grenadier platoons were never detached from their battalions, it would be but wise that they should take part in the manœuvres, as reserves, or elites, charged with covering the manœuvres of the battalion for attack or defence. The station of the grenadier platoon would, in this case, sometimes be in front, to cover the formation of the column or display of the line; sometimes in rear as a reserve; and at other times on the right or left as a flanking corps: and in all cases, this platoon would be a means of defence at the disposition of the commander. In

* See also the Regulations for the Exercise of Infantry, from the American War Department, compiled from the French, and dated 28th February, 1815.

this point of view we shall henceforward consider the grenadiers.

Evolutions of the line. (See the references preceding.)

Evolutions of the line, are the manœuvres executed by armies or *corps d'armées* to arrange its elements in the projected general order of battle, and to adapt and vary the primitive dispositions according to the modifications required by circumstances and suggested by the genius of the general. They are founded upon the manœuvres of the battalion and squadron, and consist in; 1st, forming columns of march at regulated distances, to form a given order of battle on an already known or reconnoitred position; 2d, to change the front or line of an order of battle, or part of it, and give it a new direction with modifications; and 3d, to form columns in retreat, and retire from one position to another, &c.

All the movements in evolutions should be so regulated as to be executed in order, and in the least possible time; consequently, the lines or directions of the centres of gravity of the horizontal projections of the units of force, must never cross each other, and the sum of all these lines should be the *minimum*.

The simplest problems of geometry will enable the student to understand all the manœuvres described in the regulations, and by those writers who have treated this part of the science; such as Folard, Puysègur, Turpin, Lloyd, &c. &c. Officers of the line and staff should be well versed in this part of tactics, in all its extent and details*.

On marches.

The experience of all ages, and particularly of the last wars, has proved that *marches* are the key to all military operations; and that victory ultimately sides with those troops who best understand and execute them.

Use and management of arms: fire of musketry.

Troops should be well instructed in the use and management of their arms, in combats of the fire, and of the sword and bayonet. Military writers do not agree on the manner that the infantry should fire. Some are for the fire of *three* ranks, the first rank kneeling; and this mode is practised; whilst others are for the fire of *two* ranks only. The former are for regulating the fire, and the latter for firing at will or by independent files (*feu de billebaude*).

(See The Regulations. the Encyclopædia, word "*Feu.*"

* See also the admirable General Essay on Tactics, by General Guibert. TRANSLATOR.

Value or efficiency of the fire of musketry, and the principles that ought to regulate firing.

To have a just conception of the manner in which generally the combats of fire-arms should be executed, we must consult experience and the opinions of great generals. This subject has been treated in the Encyclopedia by a writer equally distinguished for experience and talents.

It is proved by experience, that a prodigious multiplication of fires, if badly directed, produce little effect; but that fires executed with calmness, and well directed, have on the contrary a great effect, provided of not long continuance; for the delicacy of the construction of the musket diminishes its effect in proportion to the number of vollies; and it is certain that the effect of the fire is in a direct ratio to the exactness of the aim, and in an inverse ratio to the frequency of the fire. Combats of fire-arms should occasion no movements that ought to disarrange the order of battle, unless separated by obstacles from the enemy.

Consequences of the premises: two modes of firing required.

It follows from these considerations, that there ought to be two different modes of executing the fire; one for combats on accessible ground, the other for fronts covered with obstacles. We confidently declare, that the custom of causing the front rank to kneel, in order that the third may fire, is on many accounts inadmissible and dangerous, and even impracticable in the heat of battle: it can only be executed in parades, and should be entirely suppressed*. Consequently the fire of three ranks in battle could only be practicable by the ranks changing place; but such a movement before the enemy would be too hazardous, and would produce great confusion in the line; it could only be performed when the front is covered by obstacles.

The fire of three ranks impracticable in battle.

Firing by word, seldom practicable in war.

Firing by word of command, by platoons, divisions, demi-battalions, and battalions, produces a fine effect in the peaceful manœuvres of a parade, but after the first discharge becomes impracticable in war, by reason of the precision required; these

* The experience of wars has proved, that it is often difficult, and sometimes impossible to raise the first rank after they have knelt down; and that in a formation 3 or 4 deep, where more than two ranks fire, the soldiers in the front rank are often shot by those in the third and fourth. After the first round, the general practice is for the two first ranks to continue the fire, whilst the third (and fourth, if there be such) load for the second rank. TRANSLATOR.

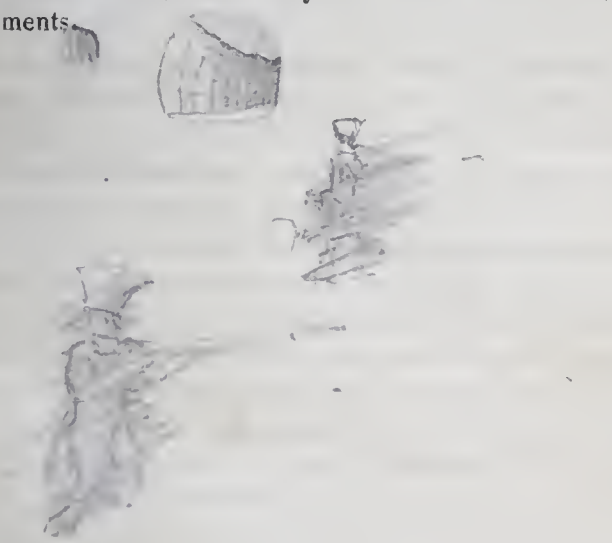
fires are from their nature badly directed, and are all perpendicular to the front.

The fire of two ranks, or by independent files, the best and most adapted to battle.

From the preceding it is obvious, that the fire of 2 ranks is the only fire that reason, guided by experience, can approve. It is executed with ease, does not jeopardize the soldiery, nor require any interior movements of the line ; and if it lessens the fire by one third, it compensates for this only seeming disadvantage by real and palpable advantages.

When the fire of the two ranks is at will, it is called firing by independent files (*feu de billebaude*) ; and when the soldiers are drilled to execute it with coolness, and to take the best aim, it is the best possible fire. The aim can never be exact unless the soldier is unconfined and has full room to adjust his piece to the object.

The practice of handing to the second rank the arms of the third, does not deserve confidence ; in the open field it produces serious evils ; but it may be used in the defence of intrenchments.



CHAPTER VI.

Calculation in mètres of the Fronts and Depths of Habitual Orders of Battle of Infantry and Cavalry, in order to draw their ground plan; Organization of separate Armies; Parks of Artillery; Service of the several Arms in War; Reflections on Complex or General Orders of Battle.

36 Calculation of the dimensions of the habitual order of battle of infantry

36. TO establish the relations between the troops and the ground that they are to occupy either for manœuvre, battle, or camps, it is first requisite to determine in linear measures the dimensions of the orders taken by the troops in these different circumstances; and then having the horizontal projection of the ground, we may make our dispositions upon it.

Facts and data furnished by experience whereby to calculate the mean dimensions of the space occupied by the foot and horse soldier in line

To calculate in mètres the dimensions of orders of battle of infantry and cavalry, we must first know the mean horizontal projections in line of the foot soldier and horseman. These dimensions have been established by tacticians approximatively from experience, and are a mean data sufficiently exact for our purposes.

A foot soldier in line occupies a front equal to 55 centimètres (nearly 2 feet), and a depth in file of 33 centimètres (13 inches): the front of 55 centimètres may appear too much, as in the Regulations only $18\frac{1}{2}$ inches ($19\frac{3}{4}$ inches) are allowed; but as many military writers have fixed it at 2 feet ($2\frac{1}{7}$ feet), we think that this is the true mean dimension*.

The front of the horseman in line=120 centimètres, or a little less than 4 feet (4 feet Eng.); his depth in the file=250 centimètres (8 feet 3 inches Eng.)

Length of the front of a battalion, and its depth. (See PLATE III, fig. 1 and 2)

To determine the front of a battalion in line, there are three prerequisites, viz: 1st, the numbers or strength of the battalion; 2d, the number of men in the depth or files of the line; 3d, the space occupied in front by the soldier. Then by dividing the number of men by the number of *ranks*, and multiplying the quotient by the factor 55 centimètres (2 feet), we find the ex-

* The front occupied by a foot soldier is calculated by tacticians who have written in English, at two feet; this even number is sufficiently near the truth for all practical purposes, and is very convenient in calculations.
TRANSLATOR.

tent of the battalion front; adding however this latter number multiplied into the number of platoons, for the spaces occupied by commandants of platoons. To find the depth of the habitual order of battle, we must remember that the distance from rank to rank is 33 centimètres (13 inches); making for the distance from the front to the rear rank 165 centimètres ($5\frac{1}{2}$ feet), or 315 centimètres ($10\frac{1}{2}$ feet) to the rank of file closers inclusive.

Length of the front and depth of a squadron (See PLATE III, fig. 4 and 5)

The rule is the same as to cavalry; if we divide the whole number of men in the squadron by the number in each file, and multiply the quotient by the given factor 120 centimètres (4 feet), the product is the length of the squadron front; taking care to add twice 120 centimètres for the front of the two sergeants on the extremities of the squadron. The depth is twice 250 centimètres ($8\frac{1}{2}$ feet), added to 60 for the distance between the two ranks; and making together 5.6 mètres, or we may say 6 mètres (20 feet).

Length of the front of the late established battalions of 314 files.

By applying these general rules to the battalion as last established, of 1066 men, the effective number of whom in file may be fixed at 942, including 78 grenadiers, or 288 battalion and 26 grenadier files; the length of the front is found to be $\overset{\text{centim.}}{55}\times(\frac{942}{3}+9)=\overset{\text{centim}}{55}\times 323=178$ mètres (nearly 200 yards). The front of the battalion, not including the grenadiers, is $55\times(\frac{864}{3}+8)=55\times 296=163$ mètres nearly (about 181 yards).

Length of the fronts of squadroos of light and heavy cavalry.

In the same manner the front of a squadron, whether cavalry, cuirassiers, dragoons, or light horse, is found. Suppose the number of men in file is 144 in the cavalry, and 192 in the light horse; then the front of a squadron of cuirassiers is $\overset{\text{mètre.}}{=}1.2\times(\frac{144}{2}+2)=89$ mètres nearly (about 100 yards): and the front of the squadron of light cavalry $=\overset{\text{mètre.}}{1.2}\times(\frac{192}{2}+2)=117$ mètres nearly (130 yards).

Extent of fronts of regimeots of infantry and cavalry.

By adding the length of the intervals between the battalions and squadrons, we find the extent of the front of the regiment, or brigade, &c. In orders of battle these intervals are commonly 20 to 30 mètres (about 22 to 33 yards) between battalions, and 6 mètres (7 yards) between the squadrons. Consequently the front of a regiment of three battalions $\overset{\text{mètres}}{=}163\times 3+\overset{\text{mètres.}}{40}=529$ mètres (588 yards); not including the 3 grenadier companies=45 mètres (50 yards).

The front of a regiment of heavy cavalry of 4 squadrons $= 89^{\text{mètres}} \times 4 + 18^{\text{mètres}} = 374$ mètres (416 yards).

The front of a regiment of *light* cavalry of four squadrons $= 71^{\text{mètres}} \times 4 + 16^{\text{mètres}} = 480$ mètres (540 yards).

These fundamental rules, and a little experience in the coup d'œil, will enable those officers whose duty it is to fix encampments, to determine at once the proportion of troops to ground.

1st Organization of masses or parts of force, or divisions.

37. The materials of a separate army, are detachments of the military forces of a state (chap. I. 5). Formerly a complete army was composed of a given number of regiments of infantry and cavalry, a park of battalion pieces, and as many more pieces of position of all calibers, serving by divisions of 6 pieces. At present, armies are composed of units of force called *divisions of an army*: a complex corps combining in itself all the elements of an army of which it is an integral.

Composition of the division.

There are often in the composition of the division differences more or less striking, and owing to particular circumstances: but it is generally composed of, 1st, 4 regiments of infantry of the line, divided into two brigades: 2d, 1 regiment of light infantry; 3d, 1 regiment of dragoons; 4th, 1 regiment of light cavalry; 5th, a park of artillery consisting of 2 divisions of 6 pieces, 1 division served by a company of horse artillery, and the other by a company of foot artillery: 6th, staff, consisting of an adjutant-general and his assistants (*adjudant-commandant et ses adjoints*), and an engineer officer. Sometimes this corps is reinforced by one or two regiments of cavalry. The division is therefore a perfect little army in itself, about 12 to 15,000 strong, and operates isolatedly or in conjunction with other divisions; it has great analogy to the Roman legion.

Formation of a grand army.

A grand and complete army is formed by the union of many divisions: to which are added, one or more reserves of cavalry, a large park of artillery, and a few brigades of engineers, together with a general staff having a General of division for chief; and the whole commanded by a *General in Chief*.

Proper proportions of cavalry and artillery to infantry, in a separate army.

The proportion of cavalry to infantry in particular armies, differs according to the nature of the country which is to be the seat of operations, and the nature of those operations. In a country not much intersected with obstacles and of a middle aspect, the proportion of force is generally $\frac{1}{5}$ of cavalry and $\frac{4}{5}$ of infantry; that is, *one reserve* of cavalry to two divisions of in-

fantry. And in an army of 50,000 men, there would be 10,000 cavalry, and 40,000 infantry; or what is the same thing, 2 reserves of cavalry, and 4 divisions of infantry.

Proportion of artillery in an army: 12 pieces to a division and 6 to a reserve of cavalry. (See Essay on the Organization of artillery by Gen. Espinasse.)

If in the formation of an army, we attach to it artillery in the ratio of one piece in activity to every 900 men, and give to each reserve of cavalry one division of horse artillery, then this arm will be in the best proportion to the others. According to these rules, an army of 50,000 men would have 60 field pieces, or 10 divisions; four of which horse, and 6 of foot, artillery. This proportion of 6 to 4 of foot to horse artillery, is the most advantageous, and better than 4 to 6.

Grand park of a separate army.

The grand park of artillery of an army, consists; 1st, of all the divisions of horse and foot artillery attached to divisions of the army, and of all their stores and munitions; 2d, of an equal number of divisions ready to march to reinforce the pieces of divisions, or supply their places; 3d, there should be 2 or 3 divisions of position, composed of 8 and 12 pounders.

The army of 50,000 men, of which we are speaking, would have a park composed as follows:—

1st. 6 divisions of foot, and 4 of horse, manœuvring 60 pieces in activity.

2d. 6 divisions of foot, and 4 of horse, in park, ready to reinforce or supply the loss of the 60 pieces in activity.

3d. 2 divisions of position pieces, composed of 12 pieces of 8 and 12 pounders. The whole making 132 pieces, served by 22 companies, 14 of foot, and 8 of horse, artillery.

Four such armies would require 528 pieces, served by 88 companies, 32 of which would be horse artillery; and as the national force contains 196 companies, there would remain 108 for the service of depôts in the rear, and of the fortresses and colonies.

And suppose that, at the depôts in the rear there be a reserve of one field piece for every 1000 men, and 6 pieces of position for every 50,000 men; then there would be 224 pieces in depôt. Consequently to put in motion four armies of 50,000 men each, we must have 750 pieces of all calibers, and 125 companies of artillery.

Calibers manœuvred by the horse and foot artillery.

As the characteristic properties of the horse artillery are celerity and rapidity, they use the lightest pieces. A company generally manœuvres four 4 pounders or 8 pounders, and two 6 inch howitzers. The foot artillery use all calibers, from 4

pounders to 12 pounders; each division having always two howitzers. The calibers used depend upon ground and other circumstances.

Men necessary in the park.

As 8 men are enough to manœuvre a piece, each company has an excess of men, who remain in the park and perform those laborious works and services that fall within the duties and province of artillery.

38. Duties of the different arms in war: those of the infantry of the line

38. Infantry of the line composes the main body of all armies; it occupies military positions, encamping on them and forming in order of battle; and besieges or defends fortresses, &c.

Duties of light infantry.

The light infantry service is more extensive; they are constantly in action to observe, harass and disturb the enemy; and are principally employed in the van guards and flanking corps, and stationed at the outmost posts. By means of these troops, marches are safely made, and countries scoured and reconnoitred: they also enter into orders of battle.

Duties of the cavalry of the line.

The cavalry of the line, consisting of dragoons and cuirassiers, follow the infantry of the line, encamping together with them, and occupying the villages in the vicinity of the camp: this cavalry forms in the first line in order of battle, to charge and break through the enemy.

Dragoons form the escort of convoys, and aid in forages; they often dismount and serve as infantry to force a post, or pass a river, &c.

Duties of light cavalry.

The duties of the light cavalry are of the most important kind; they are always in the van guards, and on the flanks, and at the advanced posts, where they *bivouac**. They are used in all reconnaissances, to scour the country, enlighten the march of columns, &c.: they enter into the second and third line in battle, according to their nature, and complete the victory by pursuing and cutting up the enemy in his retreat.

Duties of field artillery.

Artillery (art. 33.) which we shall hereafter treat more in detail, occupies military positions, and is disposed in battle in stationary or flying batteries. The horse artillery combines its manœuvres with those of the cavalry.

Duties of the engineers.

In the 2d and 3d parts of this work we shall treat at length on engineering or fortification. This arm considers the ground

* "Bivouac," to remain under arms; also the post or ground on which the troops bivouac night or day. The expression is most commonly applied to night. TRANSLATOR.

that is the theatre of operations with a view to interpose obstacles and modifications, and thereby increase the power of the other arms; as by fortifying camps, posts, villages and towns, &c.; establishing the defences of frontiers, and directing and conducting the attack and defence of fortresses.

39. Orders of battle are the sublime of war; and it is in their application that the talents and genius of the general shine pre-eminent. Such should be the clearness and promptitude of his coup d'œil, that knowing his own army and the enemy's, and their respective positions, he should be able at once to form his force in the best possible order of battle for offence or defence. With the greatest presence of mind he should be so master of all his resources and combinations, that the habitual order of battle should be but provisional, varying according to the circumstances and passing events of the battle. This theory should be studied like complicated cases, simplifying by hypothesis the state of the case to attain a result that will serve as a maxim and guide in complicated and variable situations. This too is the progress of the theory of fortification, creating and projecting simple and uniform systems, to which are subservient the modifications caused by the irregularities of ground; leaving to the officer the task of applying by his coup d'œil, his drawings and calculations, general principles to each particular case. 39. Reflections on general orders of battle.

We will suppose that the general order of battle is formed upon ground uniformly a mathematical plane, and that the army is to act in a direction perpendicular to its front.

The Greeks and Macedonians* always endeavoured to give battle upon plains; their orders of battle, founded on the phalanx, were ill suited to inequalities of ground. The phalanxes were posted at such distances from each other as the general directed, each flanked by small corps of cavalry (28). General orders of battle of the Greeks. (See art. 28.)

* It would appear from Demosthenes, that the armies of Philip were somewhat differently constituted: "For you find that the rapid progress "of Philip is not owing to his force of regular troops, but to armies com- "posed of light horse and foreign archers. With these he pours down up- "on some people already engaged in civil discord and commotions; and "when none will venture out in defence of the state, on account of their "private suspicions, he brings up his engines and attacks their walls."— *Demosthenes' Tenth Oration, commonly called the Third Philippic.*

TRANSLATOR.

General orders of battle among the Romans. (See 29.)

Among the Romans, general and regular orders of battle underwent greater changes than among the Greeks (art. 29). Originally the Roman generals formed them after the Grecian manner; but after the formation of the legion into cohorts, and the particular orders of battle that were observed at different periods, there were consequent and analogous changes in the general orders of battle. When the army was composed of many legions, the infantry as we have said before (art. 29) was in the centre, and the cavalry on the wings. The legionary intervals were more or less, according to the nature of the ground and the plan of the general; and sometimes small corps of cavalry were posted in these intervals.

General orders of battle of the moderns (See 30 and 31.)

We will not repeat what we have already said (30 and 31), and will merely observe that the general orders of battle of the moderns have been very variable, and marked by the defects of their military constitutions. But by degrees the true principles of war were recognized and acknowledged, and Europe paid due homage to the tactics of Greece and Rome. It was gradually, and between 1400 and 1630, that the greatest improvements were made in military institutions and orders of battle: the art of reconnaissances, and of posting troops according to the ground, was brought to great perfection by Henry IV. At length, in the sixteenth century, it was perceived that infantry ought to constitute the main force of an army, and that orders of battle should be founded upon this incontestable truth.

Description of general and regular orders of battle until 1792, or the order in quincunx. PLATE III, second part, fig. 1.

The principles of the Romans having obtained in military institutions, it was natural that their general and regular orders of battle should likewise be followed. Accordingly we find that their third order, introduced by Marius, is that which was with some modifications adopted in Europe until 1792.

This order consisted in disposing the army on two lines distant about 200 mètres (225 yards), the infantry in the centre, and the cavalry on the wings, and the battalions and squadrons separated respectively by intervals equal to their front: the battalion pieces were posted in the intervals of the first line. The second line was formed in the same manner, except that the battalions and squadrons faced the openings in the first. A reserve, composed principally of cavalry, sustained the army in the rear. This is the order called *Quincunx;* but it was not generally used in the last war, as the single and almost full

Orders of battle of many Generals in the last war. PLATE III, second part, fig. 2.

line, supported by a reserve, was preferred. In this latter, the infantry was in the centre, and the cavalry on the wings; the regiments and battalions were separated only by the intervals required in manœuvres, and for the retreat of the artillery and light troops; the squadron intervals were likewise very small. In this order, which had a great similitude to that of the legion anterior to Marius, the light troops corresponded to the *velites;* the heavy infantry to the *princes*, and the reserve to the *triarii*.

Reflections on the posting of cavalry; and the systems of Folard.

Thus we see that the practice of posting the cavalry on the wings, has obtained among all people, ancient and modern; but several celebrated Generals, and among others Turenne, *have in many cases* deviated from this rule. Lloyd and Folard have warmly discussed this subject, but it has not yet been treated in such a manner as to unite all opinions. That such was the practice of the ancients, is not at all surprising; their cavalry was feeble and incapable of great effects; being no more than light troops for skirmishing, it was proper to place them on the wings, to harass and alarm the enemy's flanks and rear. But the cavalry of the moderns has great firmness and is capable of immense efforts, and consequently from its nature should enter into line of battle. Folard, whose systems are founded on the deep order, never places his cavalry on the wings, which he secures by columns of infantry; but mixes his cavalry along the front with infantry, to sustain each other reciprocally. Lloyd considers the cavalry only as an auxiliary arm, to second the infantry whenever the ground will permit; and whose principal use is to ensure and complete the victory*.

Principles that should govern in the formation of a regular order of battle.

The principles that ought to regulate the formation of an order of battle, are corollaries from what we have precedingly laid

* Tempelhoff thinks, that the solidity of a line of battle depends upon the perfect union of all its parts between themselves; and that wings of infantry would be isolated, if the cavalry, which cannot fight on all grounds or every where, nor sustain an attack from the three arms combined, were obliged to retire. In support of this opinion he cites the famous battle of Hochstadt, where Marlborough forced the centre of French cavalry, and compelled the battalions that were in Blenheim to lay down their arms.

"The battle of Lowositz (1756) is also a proof of this rule, although "Lloyd attempts to invert it."—*Jomini, Lloyd, and Tempelhoff.*

TRANSLATOR.

down (26) on the particular orders of battle of the different arms.

In order that an order of battle, constituted for a direct attack, should possess a maximum of force, five conditions are required; 1st, that the infantry should be the principal force, and that its great object should be to use the bayonet; 2d, that the constituent elements of the troops be organized agreeably to the principles already explained (27); 3d, that each species of force co-operate in the general action, according to its nature, and at the best conjuncture of time; 4th, that from the moment any arm begins the action, it combat with the greatest possible number of its troops; 5th, that all arms support and protect each other.

From these evident principles it follows, that a battle should be a series of uninterrupted actions of all the arms, producing a force or power decisive of victory.

View of the conflict of the different arms.

The nature of each species of force ought to determine the relation between their respective actions. The artillery should obviously be able to combat at 1500 mètres distance (1670 yards), at which field artillery acts with effect. It is at this distance that the order of battle is almost invariably formed, and whence it advances upon the enemy; the light troops opening their fire, and the artillery selecting commanding positions on the flanks. The light infantry soon falls back, and retires under the protection of that of the line; and the latter when distant 150 mètres (170 yards), the primitive point blank, pours in one or two fires, and then rushes to the charge. After the shock, the light infantry that had fallen back in the intervals, should use the bayonet or fire, and combine their efforts with those of the heavy infantry. This is the moment for the cavalry to charge, for the fire of either side has ceased to produce effect. Passing through the intervals, the cavalry should charge through the breaks and openings made by the infantry, and take in flank the corps that still resist. By such manœuvres, which bring all the forces into conflict at almost the same instant, the enemy's line would probably be broken and overthrown, and all its corps totally routed.

Analysis of the two preceding orders of battle.

The principles which we have here developed, show at once the defects and impropriety of the two orders of battle that we have described. The chief defect is stationing the cavalry upon the wings, by which the cavalry and infantry but feebly

support each other, and the line of battle is divided into three almost independent parts, badly connected. The cavalry does not possess mobility; and though it alone is insufficient for self-protection, and cannot stand against the fire of artillery or infantry, yet it is here posted in the most important part of the front. Accordingly in neither of these dispositions does the cavalry fulfil its true destination*. If we examine the formation of the

* The speed of charging cavalry should be progressive, increasing as they approach the enemy. For instance, if the troops to be charged be at a distance of 600 paces, the speed of the charging body will be thus regulated:—

The 1st 200 paces, on the small trot.	The next 150 paces, at full gallop.
The 2d 200 paces, on the full trot.	The last 50 paces, at full career.

The shock of cavalry is more analogous to that of a physical body or inanimate mass, than that of infantry. The general order of battle should be two deep, not because of an imaginary pressure from the 2d rank, but to supply the loss of the killed and disabled, and to have an increased number of combatants when mingled with the enemy.

"Cavalry in battle, when not formed in line, is greatly divested of its "force, and is weak and defenceless. Instead of a second line, reserves "well posted are to be preferred."

"Columns of cavalry are only to be used to exaggerate or conceal your "numbers, or to gain by a rapid march a post, height, defile, or flank, and "thence fall upon the enemy's line. There are cases however when co-"lumns of cavalry may be used to charge; such as when the infantry are "surrounded, or present an exposed flank or angle unprotected by fire, "and which may be attained under cover: these columns must be in open "order, and of half or whole squadrons in front, with intervals of 30 to 50 "paces. They must not be too deep, not exceeding four subdivisions; "for rather than increase the depth, augment the front. Greater depth is "unnecessary; for if repulsed, and you persist in the attack, you will form "about the infantry a breast work of wounded and dead men and horses. "If the leading squadron or subdivision be defeated, instantly advance the "following at great speed upon the *nearest collateral* parts of the point of "attack; this will decide the victory."

"The great advantage of cavalry when superior in numbers, is to ad-"vance in line and by superior front, outflank and turn the enemy, who, "when inferior, should rest his flanks upon supporting points or ob-"stacles."

"When the artillery and infantry fires have disordered the enemy, "then is the moment for the cavalry to charge."—*Guibert's General Essay on Tactics.*

The cavalry should be posted on that flank where they can best act; and not on both flanks equally, without regard to ground. Among the fatal errors committed by Prince Charles of Lorraine at the battle of Prague,

heavy infantry in the first order, we will find that being divided into two lines, only one-half of it can act; and that generally the overthrow of the first line produces the disorder and rout of the second; whilst the confusion and disaster is increased by the battalion pieces intermingling in their flight with the infantry, along the front of which they had been distributed.

These defects do not exist in the second order; there, from the moment of attack, the infantry displays its whole force, supported at the proper juncture by the reserve, which in case of disaster becomes its shield: the movements of the infantry, no longer encumbered with artillery, are more free; and though detached from this arm, it is easy to judge from the effect and panic which it produces among the enemy, that it is preparing for the infantry the road to victory. If in either order we suppose that the infantry remain in light order or displayed, they are then only fit for the combats of fire arms, and not for exertions with the bayonet*. Consequently these two orders of battle are not formed upon the true principles of attack and defence.

Result of the analysis

Sketch of an order of battle according to the principles established. (See PLATE III, 2d part, fig. 3.)

The regular order of battle which we propose to suggest, is like that of the ancients, founded upon the infantry of the line; all other arms being only auxiliary. The line of battle should therefore be composed of battalions presenting an extent of front equal to the enemy's, preceded by the horse and foot artillery† distributed into flying batteries and affording direct, cross, and flank fires. The battalion intervals should be 100

was that of following the old rule of placing cavalry on both flanks, although his left was *inaccessible*. He rectified his disposition, but at rather too late a moment. In general it may be laid down as an incontrovertible maxim, *that troops are to be posted according to the nature of the ground, and that each arm should be upon that ground which is best adapted to its weapons and mode of combat.* TRANSLATOR.

* This assertion must be understood with qualications. After a line has been thinned and disordered by the fires, it may be charged and overthrown by another line of infantry. This occurs very frequently in battles.

Decisive attacks with the bayonet on the commanding points or keys of a line or position, are most generally made by columns of attack of a division or demi-battalion in front at diminished distance, and the columns concealed and covered on the flanks by battalions forming with their heads a continuous line.—*See Jomini.* TRANSLATOR.

† The fire of artillery may begin to be relied upon at these distances:

mètres (111 yards), each covered by a demi-battalion of light infantry, forming a kind of moveable bastion, and pouring into

16 p'rs (equal to our 18 p'rs) with cannon ball, at 1130 yds. with grape ——
12 .. do. at 920 to 1050 yds. with grape 520 to 650 yds.
8 .. do. 820 to 920 yds. with grape 300 to 600 yds.
4 .. do. 820 to 920 yds. with grape 300 to 500 yds.
6 inch howitzers at 22° elevation, 1200 yards: this angle does not permit *ricoches*

"If possible, batteries should never be formed opposite to that part of "the line they are intended to operate upon; the fire should take the line "obliquely or in flank. If the batteries be numerous, their fires should cross "and flank each other."

"It is a common *error* to suppose that artillery should be posted on "*high ground;* a height of 15 to 22 feet in 620 yards, is advantageous; "but a greater height is not, as the shot plunges and does not *ricochè*, and "the exposure of the enemy decreases as they approach.

"Artillery must not fire at artillery, except in extraordinary cases; it "should be posted on the salient parts, and if possible, seize the prolonga- "tions or flanks of the enemy's line or column, in order to rake it. Nor "should artillery be posted on one right line, for then if taken in flank at "any point, every battery will be enfiladed."

In posting artillery in the field, great attention should be paid to avoid steep declivities, ditches, ravines, and marshes, or situations precluding forward and retrograde movements. If possible, artillery should not be posted immediately in front of troops, nor behind them on small elevations; for in both cases you present a double object to the fire of the enemy, and in the latter you gall and often kill your own men. In attack, the heavy calibers should be on the refused flank, and the light pieces on the point of attack; except when strong positions and works are to be forced. The heavy calibers should be used in false attacks. In open countries the best defence and support for artillery, is cavalry; the reciprocity of their support is wonderful. The artillery should be concentrated on selected points, and must keep up and in relation with the movements of the line: but they must not be too much concentrated, except in particular cases, as when they bear on columns of cavalry or infantry, or points of a position, or defile, &c.

Ricochè firing is very advantageous in the field, and should be more practised; but shot will not ricochè on marshy grounds. Generally round shot is more effectual than *grape*, because of ranging farther and of ricochès.

The proportions of ammunition in the field are, with every piece of artillery, 200 rounds; for every infantry or light infantry man, 60 rounds, besides his cartridge box being filled.

Artillery should never be abandoned without the best reasons, and then its last fires ought to take place when the enemy are within a few paces; these last fires are so destructive as often to repulse the enemy.

It is seldom worth firing at a few men; the fire ought to be directed at worthy objects, or be reserved. Never fire gun for gun.

the enemy an oblique and cross fire. The cavalry must be stationed in the rear of the infantry, and out of musket shot; the squadrons opposite the intervals of the line and preserved untouched till the moment of taking part in the conflict.

The battalions of the line after the first fires, form into colamns of attack, each column formed by the junction of two demi-battalions in column of platoons; so that when the column has broken the enemy, each demi-battalion will display and take the enemy in flank, &c.

From this simple and methodical disposition it is evident, that the course of the battle would be as described. The artillery placed in the van, opens its fire within good distance, and is then seconded by that of the light infantry; the infantry of the line then delivers its fire and forms into columns of attack, whilst the light infantry and the artillery fall back to the rear; the columns then rush on to the charge. At this juncture the cavalry, and likewise the light infantry, rapidly advance through the intervals, and penetrate every part of the hostile line.

Comparison of this order with those in use (see PLATE II 2d part. and its explanatory table)

This order of battle, which we have drawn in Plate III (second part) fig. 3, when compared with the other two (figs. 1 & 2), appears to have decided advantages and superiority. All parts of this line form only one front, sustaining and protecting each other according to their nature: the front of this line is of equal extent with the others, and it possesses a force and activity which those do not. Their thin battalions would be pierced and broken in an instant by the columns of attack, and the field would be quickly covered by the light infantry and cavalry. In those two orders, the cavalry being on the wings, would be soon thinned and crippled by the artillery and musketry, and could not stand the attack of the infantry opposed to them: if they attempted to turn the flank of the former, their own infantry would be uncovered, and inevitably defeated.

It may be objected to this system, that it has the defects of

We may conclude with this maxim: "Diminish the quantity of your "artillery, and make its perfection consist in producing great effect by a "small number of pieces. Let your artillery institutions be more perfect "than numerous."—*See Guibert's General Essay.*

TRANSLATOR.

Folard's, and that the artillery would make terrible havoc in the columns of attack. But let it be observed that these columns are only formed at a distance of 200 mètres (222 yards), and then the conflict is so warm and rapid, that they could scarcely suffer more than one or two discharges, and would then most probably capture the enemy's artillery. Besides his artillery, if distributed along the line, would suffer severely from the fire of the light infantry.

Plate III (second part) exhibits a sketch of three orders of battle for a complete division consisting of 12 battalions, 1 regiment of cuirassiers, 2 regiments of dragoons, 2 regiments of light horse, one regiment of light infantry, and 2 divisions (one of horse and one of foot) artillery.

Irregular orders of battle; principles that should govern their formation.

Irregular orders of battle are as various as the ground on which they are fought; depending greatly on the ground or position of the enemy, and the formation of his line of battle.

It is only by studying the dispositions of celebrated generals under various circumstances and on varieties of ground, that we can form a conception of the infinite number of the different orders of battle that have been employed, and of the manner that a leader of talents, and of quick and clear *coup d'œil*, applies to each particular case the general maxims of the science.

Thus *Napoleon*, who conquered Egypt with an army composed only of infantry and artillery, must have adopted the *deep* and close orders of battle, and flanked his infantry corps by cross fires of flying batteries; for he had to contend with a numerous cavalry, brave as the knights of old, but ignorant of the art of forming in corps of close compacted sub-divisions.

We hope to yet see published a complete and systematic account of all the battles and combats of importance in the last war. This work, unequalled of its kind, will be the offspring of an institution whose members are daily occupied in collecting and digesting the materials to perfect the science and serve as a basis for military operations. This institution has long been directed by Generals who unite the profoundest theories to the most consummate experience. The matters that will be treated on in this work, should be the subject of the meditations of all young soldiers ambitious of advancing the national glory by serving in the career of arms.

40. Theory and foundation of the rules of grand tactics which relate to the attack and defence of two hostile *corps d'armée* acting on uniform ground.

40. Grand tactics, considered in relation to two armies or bodies of troops acting against each other, prescribe certain rules for the conduct of the attack and defence, founded on the simplest theory, and from which are deduced as consequences the most copious and general principles for the choice of camps and positions, and for conduct in battle, &c.

Let us suppose the two corps A and F equal in all their elements, and similarly disposed in their respective orders of battle, both moving on a plain with an intention to fight and conquer each other: let F be the enemy's corps, and A the attacking body.

Positive force of troops PLATE VI. fig 6.

The power with which a body of troops in order of battle act perpendicularly to their front, is what we will call the *positive force* of that corps, and of which we have acquired a very good idea (art. 4 and 5) from facts and experience, the basis of minute tactics.

The line of the centres of action; and the angle of attack.

The *line of the centres of action*, is that line which joins the two centres M and N of the horizontal projections of the two corps, and is always at right angles to the front (*cd*) of the corps A. The *angle of attack*, is the angle *b*MN formed by the line of the centres of action with the half front M*b* of the corps F.

Weakness of the flanks and rear of an order of battle

From his physical constitution, man, considered in a state of war, is defenceless on his flanks and rear. This weakness of his nature he carries with him into orders of battle, and it is there strongly felt. Accordingly the flanks and rear of an order of battle are three very weak points, in which an attack generally leads to the most complete success.

Consequence, confirmed by experience.

It therefore follows, that whenever the corps A can attack in flank and rear the line of battle F, it brings into action all its *positive force* with the greatest advantage and effect. This fact is confirmed by all experience.

Instance of equality between the positive forces of the two corps A and F; momentums of the *positive forces*.

It is evident that if the line of the centres of action MN be perpendicular to the front of the corps F, then the positive forces would be in equilibrium, for there would then be no reason that the attack should vanquish the defence: but this is the only position or case of equilibrium. For if the corps A move to the position A^1 on the right or left, from that moment the angle of attack *b*MN^1 becomes acute, and the equality necessarily vanishes; because, 1st, the plane of fire of the corps A^1 cuts the front of F, whilst that of the latter is oblique, and the part Kd^1 of the front of A^1 which extends beyond the extreme

line of fire $r^1 s^1$, is not within scope of the fire, &c.; 2d, the positive force of A^1 acting against the flank G of the corps F, must produce extraordinary effect. The more we increase the acuteness of the angle of attack, the greater is the augmentation of the positive force of A; and this force will receive an extraordinary impulse when the angle of attack passes from *zero* to the negative side.

The angle of attack, counting from the right angle, is consequently a species of lever of different lengths, imparting a kind of *momentum* to the attacking force.

From this principle it follows, that the powers of the force A, as it moves from its primitive position, are constantly increasing, whilst those of F every moment decrease.

Respective positions of two corps, and power of the momentum of the attacking corps in each position.

Therefore, when the angle of attack is a right angle, there is an equality; when this angle becomes equal to half a rectangle, the effect of the momentum of the force A is increased *one third;* and when the angle of attack equals one fourth of a right angle, the momentum increases the effect of the attacking force more than one half; but when the angle of attack is *zero*, the force of F is almost nothing, whilst that of the attacking body is more than quadrupled: finally, when the angle of attack becomes negative, the corps F is absolutely powerless, whilst the force of A produces necessarily its destruction.

When the angle of attack is equal to a right angle, the corps are said to be in *direct position;* when this angle is equal to half a rectangle, a *flank is menaced;* when it equals one fourth of a right angle, the corps F is said to be *enfiladed and outflanked;* when the angle is zero, the corps A is said to be *in "potence"* to the corps F, and this latter *is taken in flank;* when the angle of attack is negative, the corps F is said *to be taken in reverse:* lastly, when this angle is negative and equal to a right angle, the corps F is said to be *taken in rear and cut off by the corps A.*

This theory applied to grand tactics.

This very simple theory extends to grand operations, which are the province of grand tactics, and relate to the choice of camps and positions and the knowledge of their strength, and to the movements of armies or *corps d'armée* acting on the offensive or defensive.

In fact it is easy to understand, that if the two supposed

corps A and F were replaced by two armies, and the line of the centres of action were prolonged about two to six myriamètres (12½ to 37 miles, nearly), this would be only a particular application of the general principle, and by which the properties laid down would be displayed in all their force. We will hereafter enlarge upon this most important subject, upon which the success of the ablest projected operations* depends.

* This serves to demonstrate the fundamental rule of grand tactics and operations—*The secret of victory, is to operate with superior numbers or masses against one or two points, or to bring the whole or greater part of your force to bear upon a point where the enemy has only a small portion of his to resist you; and where, if victorious, you will take in flank or reverse his whole line or position.*

To gain this point or concentrate your masses, your march must not only be masked by either ground, darkness, or false attacks, but it must be executed with *great celerity*, and conducted with wisdom, knowledge, and skill. We must be perfectly acquainted with the camp and positions of the enemy, the roads, and the country; and the march must be so regulated, that the columns will be able to separately or jointly defend each other in case of the enemy discovering our intention and advancing to anticipate the blow by becoming the assailant. Hence it is that all successful operations depend upon *acting with celerity and in mass;* and the army that best understands and executes this principle, will be ever victorious, in spite of disparity of numbers and poverty of means. The great victories of Alexander, of Pyrrhus, Hannibal, and Cæsar, the triumphs of Frederick, the battles of Marlborough and Eugene, and the conquests and achievements of Napoleon, and all those mighty deeds that mankind have beheld with breathless terror and admiration, were accomplished by an observance of this principle; and the neglect of this rule, is the best proof of the weakness or folly of any plan of battle or campaign; for if a project be not *right*, it must be *positively wrong*.

TRANSLATOR.

CHAPTER VII.

Use of the two arms, Artillery and Fortification; service and material of Artillery; description of Artillery Pieces or Ordnance; the Charge; Gun-Carriages; theory and practice of Gunnery; Batteries, &c.

WHAT we have already said of artillery (art. 9, 24, 25, and 33), includes the first notions that are requisite in illustrating the *other* arms, but is inadequate for the purpose of this Treatise. So great is the influence of artillery on all the operations of war, so connected and combined is it with fortification, embracing so extensively physico mathematics and the mechanic arts, that the train of our reflections on the science of war in general, and the portion of this work that will be specially devoted to fortification, impose upon us the necessity of treating this arm in a special chapter.

41. Use or objects of the arms of artillery and engineering.

41. The use of artillery has two chief objects:

1st. To act in fields of battle and cripple or partially destroy the resisting enemy.

2d. To destroy in every situation the enemy's artillery, to batter down the obstacles created by the art of engineering, and to clear the way for the assailants to come in contact with the assailed.

Hence it follows, 1st, that the artillery cannot effectually destroy the works created by engineers without a knowledge of their configuration, construction, and resistance; 2d, that engineering cannot raise its defensive works without a knowledge of the nature and effect of artillery projectiles.

Great importance of the two arms, artillery and engineering.

So great is the importance of artillery and fortification, that they are now ranked among the constituent elements of a complete army; they vary the powers of the other arms, and render practicable *to the* latter, operations otherwise *impracticable*.

Duties actually belonging to the artillery.

The duties attached to the artillery service are,

1st. The direction and establishing of manufactures and foundries of all kinds of arms, gun-powder, fire-works, and military implements:

2d. The safe keeping in arsenals, of powder, shot, shells, &c:

3d. The construction of gun carriages and waggons for manœuvring artillery pieces:

4th. The making of cartridges and fire-works:

5th. The establishing of depôts, and preservation of these stores, &c. in arsenals:

All these branches form the stationary service (*service des residences*), and are founded upon civil and hydraulic architecture, mechanics, and chemistry applied to the arts.

6th. The exercise of the troops in all artillery field manœuvres; these manœuvres are called the evolutions (*le polygone*):

7th. The formation and direction of parks for armies and sieges:

8th. The arming and providing, in concert with the engineers, fortresses and intrenched camps with artillery and munitions of war:

9th. Establishing bridges across rivers and streams, in concert with the engineers, during the operations of a campaign:

10th. Reconnaissances of positions and fields of battle, in order to determine the posting of fixed and moveable batteries:

11th. Reconnoitring besieged places, to determine, in concert with the engineers, the number and posting of the guns:

12th. The construction of the *epaulments* of all kinds of batteries, whether on the sea coast, military positions, or in fortified works.

These constitute those branches of the arm that are purely military.

(See *Le Manuel de l'Artilleur*)

The study of all these in detail, is the duty of the schools of practice; the student may consult the works of the celebrated Gribeauval, and of other artillery officers who have written on the various branches of their service.

42. Service of artillery from its origin; offices of Grand Master of Artillery, Lieutenant General, and others under the Grand Master.

42. Before the discovery of gun-powder, the Grand Master of the cross-bows, and the artists under his orders, had the direction of the manufactures of missile weapons and warlike machines; but after the use of fire arms this important office was changed into that of *Grand Master of Artillery*, for superintending the manufactures and armories. Of all the kings of France, Francis I established the greatest number of regulations respecting artillery. The office of Grand Master is as old as 1291; at first the functions were distributed among many officers, but in the year 1493, under Louis XIII, they were intrusted to only one. The offices of Lieutenant Generals, Quarter Masters (*Marèchaux des Logis*), Commissaries, *Commandans des Equipages*, Majors of artillery, Captains of the

train (*Capitaines de charroi*), conducting officers, pointing officers, &c. were created afterwards.

Corps of troops under the orders of the Grand Master.

There were under the orders of the Grand Master many corps of troops, to guard and manœuvre the artillery, viz : the regiment of fusiliers, (afterwards royal artillery), the regiment of bombardiers, the companies of cannoniers, sappers, and workmen, and the companies of miners.

Formation of the regiment of fusiliers, which in 1693 took the title of royal artillery.

Under Charles VIII and Francis I, it was the prerogative of the Swiss to guard and defend the artillery ; this honour they enjoyed until the formation of the regiment of fusiliers in 1671. This regiment, the first that was armed with the musket and bayonet, consisted originally of 4 companies ; one of cannoniers, one of sappers, and two of artificers in iron and wood, charged with the construction of bridges. Before the Dutch war in 1672, the corps was increased to 22 ordinary companies, and divided into 4 battalions. In 1677 the regiment was increased by 4 battalions of 15 companies each ; but it was soon after reduced to 5 battalions. Between 1679 and 1689 there were raised 12 companies of cannoniers, who were not included in the organization of the battalions of the regiment. In 1693 this regiment took the name of *royal artillery*.

Formation of the regiment of royal bombardiers.

The regiment of *royal bombardiers*, for the service of mortars, originated in the raising of two companies about the year 1671. In 1684, thirteen more companies were raised, which made the regiment consist of 15 companies. In 1706, thirteen more were raised, to form the regiment into two battalions.

Formation of the corps of miners.

The first company of miners was formed in 1679, and was commanded by the engineer Goulon ; three more companies were successively raised about 1706.

Re-organization of the artillery service in 1721 ; institution of schools of theory and practice.

In 1721 the necessity was felt of a better organization of the artillery service, and of providing for the officers and soldiers means of instruction, by establishing schools of theory and practice in the places where the battalions were in garrison. The 4 battalions of royal artillery, the regiment of bombardiers, the companies of miners, &c. (forming 40 companies in 5 battalions), were assembled at Vienne. These battalions were stationed in the five fortresses of Metz, Strasburg, Grenoble, Perpignan, and La Fère, where schools of theory and practice were established.

Formation of 7 regiments of artillery in 1756.

In 1756 the corps of artillery was enlarged and formed into 7 regiments, each regiment having its particular school : the

companies of miners still continued to form part of the corps, having also their school.

This formation has not since sustained any remarkable changes; the present organization (art. 25) differs from it only by the sappers and miners having been transferred to the engineers corps, and by the introduction of the service of horse artillery.

Origin, formation, and properties of the horse artillery

The horse artillery was originally called *flying artillery*, and is very modern; the *great Frederick* was the first who introduced the use of it into his armies: after his example, the French have since the beginning of the last war made great use of it.

This mode of using artillery has peculiar properties, which in many circumstances constitute it an invaluable arm. The promptitude of its movements, and the velocity with which it moves from one position to another, enable it to combine its manœuvres with those of other arms, without danger of embarrassing them. In consequence of these characteristic properties, and of its rapidity of movement in attack or retreat, it enters into the formation of all orders of battle however moveable. A company of horse artillery manœuvres 6 pieces, or 4 cannon and 2 six inch howitzers.

We must observe, that the use of this arm should be moderate, because of its great expense; a company in time of war costs about 112,000 francs ($21,000), and in time of peace about 65,000 francs ($12,025); whilst a company of foot artillery in time of war costs only 60,000 francs ($11,000), and in time of peace about 28,000 ($5,180): one regiment should suffice for an army of 50,000 men. The main body of the troops of this arm should be composed of foot artillery; these troops are more patient in their duties and works, more careful of their equipages and implements, and the effects of their efforts are more certain.

Important consequences resulting from improvements in artillery.

The successive improvements in artillery have for a long time constituted the most prominent feature in war; it has, in our days, become one of the principal forces of an army, and a powerful barrier and safeguard of states and kingdoms. The power of this arm, darting to great distances projectiles that overthrow or destroy all that stand adverse, must necessarily have changed the modes of combat. Battles which formerly commenced only when the armies were in contact, now begin

afar off; and habitual orders of battle which were deep (*profond*), necessarily became light and thin.

43. Principal objects composing the material of artillery, and the principal substances used in the construction of fire arms.

43. The material of artillery consists principally in all kinds of artillery pieces (*bouches à feu*), and their appurtenances, such as:

1st. Powder, balls, bombs, howitzes*, and generally every thing relating to the charge and firing of ordnance.

2d. Gun carriages, waggons, implements, and every thing requisite for the manœuvring and transportation of cannon.

3d. All kinds of fire-works employed in wars of sieges.

Composition of powder and fire-works.

The chymical composition and method of manufacturing gunpowder, are rendered familiar to the students by the courses of chymistry applied to the arts, and of manipulation†. The basis of the composition of fire-works, is powder mixed with various inflammable substances that modify its combustion. A knowledge of these minute arts is acquired in the schools of practice (*application*).

Metallic substances used in the fabrication of fire arms. (9)

Since 1330, the substances used for the fabrication of fire arms, are, copper, cast and wrought iron, sheet iron, brass or bronze, and steel; and the success of their use has been in proportion to the progress of chymistry applied to the arts. These substances are of the greatest importance in the arts. In the course of the application of chymistry, the details of their properties, and the methods of preparing them for the fabrication of cannon and other fire arms, are fully explained.

(See Gaspard Monge's work on the founding of cannon)

Difference between land and sea artillery.

The immense quantity of artillery used for arming fleets and supplying the navy, introduced into that service the use of cast iron guns, as most economical. The immobility of these batteries, and their infrequent use, render this kind of artillery most proper for sea service. But it would be impossible to use them in the land service, because of the weight and dimensions they would require in order that their resisting force, which depends upon the tenacity of the metal, might be adequate. Besides, the feeble tenacity of cast iron, and its disposition to oxyde and chamber, preclude such pieces from sustaining the action of the quick and continued firing which takes place in the course of a siege or one or two campaigns.

Wrought iron used in the fabrication of small arms.

Wrought iron possesses all the properties to constitute good

* The shell for firing from howitzers.

† The processes in chymistry and the arts.

land artillery ; but the expense and difficulties of fabrication do not permit the use of it ; and it is only used for small arms and swords and bayonets.

Land artillery made of brass.

Cast iron having been rejected for land artillery, the experiment was next tried whether copper possessed sufficient resistance and lightness to form a good field and siege artillery.

The first bombards, cast about the end of the thirteenth century, proved that it possessed the requisite qualities. This metal is soft and malleable, and has $\frac{2}{3}$ of the tenacity of wrought iron ; but like all other metals is disposed to oxyde ; and though it combines in all kinds of relation with oxygen, yet it has not this disposition so strongly as tin or iron. Copper in its pure state is too soft and malleable for cannon, especially for large guns ; the action of the inflamed powder, and of the ball, producing in the bore cavities and indentations that give a false direction to the shot. Accordingly experience has shown, that by mixing a small proportion of tin with the copper, an allayed metal is obtained, which though a little less tenacious and more brittle than pure copper, is tougher and harder. The best proportions for gun metal are, one part of tin to ten parts of copper.

Brass produced by mixing one part of tin with ten parts of copper. (See Monge's work.)

We forbear entering into the details of the process of casting, founding, and forging, &c. &c. ; arts depending upon the application of chymistry and mechanics, and a knowledge of those ingenious inventions, by which are produced those superior models in which the French artillery rival that of all other nations. It is in the schools of practice that the students will perfect themselves in these branches.

44. General form of artillery pieces.

44. All cannon have the general form of a truncated cone of greater or less length, cylindrically hollowed around its centre or axis to a certain depth. The form of a cannon is consequently a solid of revolution, generated by the revolution of its profile about the axis of the bore, and determining the thickness of the bottom and sides. The profile must swell towards the extremity of the piece, to prevent the falling out of the charge by the percussion of the shot and action of the powder. This form has been determined by the use of artillery. The part nearest the charge must be capable of resisting the expansion of the powder ; that which is next must not yield to its pressure ; and the extremity must resist the shock of the discharge.

The generating profiles of the various kinds of artillery pieces, are modifications of this general profile; each particular model resulting from the species of projectile to be thrown from it in the various scenes of war. Hence artillery is divided into two kinds: siege artillery, for the attack and defence of places; and field artillery; and of each kind there are several species.

Generating profiles of artillery: artillery divided into two kinds, and many species.

Siege and garrison artillery comprehends many species of cannon, mortars, howitzers of great ranges, stone mortars, and grenades.

Siege and garrison and field artillery.

Field artillery includes many species of guns, and the 6 inch howitzers.

Many trials were made before the profiles at present used, and after which all artillery is modelled, were adopted: the surface of the exterior is not formed by a straight line, but by an assemblage of straight lines, some parallel, and others more or less inclined towards the axis of the piece, from which they are more or less distant, and united to each other by curves or mouldings.

Nomenclature of the different parts of a gun. (See PLATE IV, and *L'Aide Memoire de L'Artilleur.*)

The several parts of the profile of a cannon bear the following names: counting from the rear of the piece, we have:

1st. The knob and wreathed bottom (*le bouton et le cul de lampe*). (1, Plate IV, fig. 2.)

2d. The cascable or bottom of the bore (*la culasse*).

3d. The base ring (*la platebande de la culasse*). (2.)

4th. The first and second reinforces (*le premier et le second renforts*). (3 and 3^1.)

5th. The chase (*la volée*). (4.)

6th. The muzzle and its swell (*le collet et le bourrelet en tulip*). (5.)

7th. The trunnions and their rimbases (*les tourillons et leurs embases*). (6.)

8th. The dolphins or handles (*les anses*). (7.)

9th. The touch-hole or vent (*la lumière*). (8.)

10th. The point of sight or swell of the muzzle (*le point de mire ou renflement du bourrelet*). (9.)

11th. The bore (*l'ame*), or perfect hollow cylinder, the diameter of which is the *caliber* of the piece.

The caliber of the piece should exceed the diameter of the shot by half a centimètre ($\frac{1}{5}$ of an inch), so that the ball may

Caliber of guns; windage; designated by their calibers.

be easily rammed home. 'Tis this difference between the diameter of the bore and of the shot, that is called the *windage* (*le vent*). Cannon are distinguished by their calibers; those which throw a ball of 24 pounds, are called 24 pounders, &c.

Improvements in the casting and classing of artillery.

For a long time there was neither uniformity nor order in the casting of cannon, and their weight and dimensions were so great that very few could be moved with armies; so that their use was principally confined to sieges, for attacking or defending. In 1732 regulations were adopted which ordained that thenceforward the castings should be of five calibers only, viz: 24 and 16 pounders for the war of sieges, and with a length of bore of 25 diameters of the shot: 12, 8, and 4 pounders, for field service; length of bore for 12 pounders 24 diameters of the shot, for 8 pounders 25 diameters, and for the 4 pounders 26 calibers. Notwithstanding these improvements, artillery was still too heavy to be adapted for field service.

The war of 1757, and the introduction of a lighter and more perfect artillery into the Prussian army, convinced our officers of the necessity of placing the artillery in better relations with the other arms, by giving it greater lightness and mobility. Accordingly for the service of the campaign of 1760 the calibers of the 12 pounders were increased to 16 pounders, and the calibers of 8 pounders to 12 pounders.

At length in 1765, the celebrated Gribeauval appeared, and viewing all the branches of the service with the eye of genius, ordered experiments to be made at Strasburg to determine to what weight and dimensions field pieces might be reduced without diminishing their requisite ranges and powers; he himself directed the experiments in the presence of Marshal Mouy. The result proved that the light short pieces gave sufficient ranges for field operations. Thus artillery acquired lightness and advantages till then unknown. In consequence of these experiments and discussions, which constitute an epoch in military science, it was decreed that there should be calibers for sieges and garrisons, and calibers for field service; that the former should be 24, 16, 12, and 8 pounders; and the latter 12, 8, and 4 pounders, and 1 pounders for light troops. The length of the bore for garrison and siege pieces was fixed as before at about 24 calibers of the shot, and that of field pieces was reduced to about 16 diameters.

Enumeration of the calibers adopted by Gen. Gribeauval and in use ever since. (See PLATE IV, and the Table of Dimensions.)

Necessary data to draw the profiles of cannon; thickness of the sides, and position of the axis of the trunnions, &c.

By a series of experiments at different periods, the thickness of the sides of the various species of cannon at the different parts of the profile, were determined. The axis of the trunnions are so placed that the rear part and chase of the gun, are not quite in equilibrium, the weight of the former exceeding the latter by $\frac{1}{40}$ of the whole weight of the piece. This difference is necessary to the facility of manœuvring, and to the steadiness of the piece.

The axis of the trunnions is perpendicular to the plane that cuts its centre through the axis of the bore: these two axes might without any inconvenience be situated in the same plane, but hitherto the former has been placed beneath the latter. In garrison and siege pieces, this axis is one radius of the trunnions below the axis of the piece; but in field pieces it is only $\frac{1}{12}$ of the caliber below.

The bottom of the bore is made concave $\frac{1}{8}$ of the caliber. From the base ring to the front of the trunnions, the length is $\frac{3}{7}$ of the piece; the first reenforce containing two of these sevenths.

Reflections on the profiles of guns and mortars (PLATE IV, fig. 1.)

It is proposed, to make greater corrections and improvements in the profiles of cannon and mortars, to reduce them to the simplest form, and as near as possible to the truncated cone. In this event the first and second reenforce would form but one line, and most of the mouldings would disappear. Fig. 1st gives a general idea of these changes, in which the axis of the trunnions is very little below that of the piece.

Howitzers and howitzes. (See 2*d part* of PLATE IV, and the Table of Dimensions.)

The howitzer is a modern invention, known only since the Dutch war in the reign of Louis XV. The first were cast at Douai in 1749. The howitzer (*l'obusier ou haubitz*), is a kind of mortar, resembling in form a very short cannon, and manœuvred in the same way; its length is about 12 decimètres (nearly 4 feet).

Two species of howitzers.

There are two species of howitzers; one for throwing 6 inch shells, and the other for 8 inch shells: the first is for field service, and the latter for the attack and defence of places.

Parts of the howitzer.

The parts of the howitzer are, the chace, the reenforce, the cascable, the knob and "*cul de lampe*," the trunnions and their rimbases, the dolphins, the vent, and the chamber. The howitz (*obus*), is a hollow sphere of cast iron, without handles; and has like the bomb a cup (*culot*) and eye, to hold the charge and receive the fusee.

Description of the howitz. (See Table of Dimensions.)

The sides of the howitz are 10 to 12 lines in thickness, and the cup 14 to 15 lines. The cup (*culot*) might be suppressed, and then the howitz would be of the simple form of a hollow ball. The small depth of the howitzer facilitates the placing of the powder in the chamber, and of the howitz in the bottom of the bore ; it is fired in the same manner as cannon.

Properties of the howitz.

The howitz possesses many of the properties of the ball and of the bomb shell ; like the first, it strikes and ricochès ; and like the latter, bursts amidst squadrons and battalions, fires houses and magazines, ploughs up intrenchments, and burying itself in the masonry or embankment, scatters and soon ruins the parapets in which they explode.

Mortars and bombs.

The mortar and bomb are only used for the attack or defence of places ; and it is in the attack that their powers are most felt. This weapon was only known 200 years after the invention of cannon, and was first used by the Turks at the siege of Rhodes, in 1522 : it was by the use of this arm that Marshal La Force, in 1634, made himself master of the castle of La Mothe.

From its first invention, this arm has sustained great alterations in form and dimensions ; in sieges it is the most terrible weapon that the assailants can employ.

The mortar and bomb. (See 2d *part* of PLATE IV and the Table of Dimensions)

The mortar is a kind of large cannon about 9 decimètres (3 feet) in length, throwing a large projectile called a bomb, of 8 to 12 inches diameter.

In the old mortars, the trunnions were attached to the extremity of the cascable ; they were divided into two parts of very different diameters ; the *first* was next to the cascable, and comprehended the chamber for the powder ; the second part comprehended the bore, in which the bomb was placed upon the mouth of the chamber.

Names of the several principal parts of the mortar. (See *L'Aide Memoire du General Gassendi.*)

The several parts of the mortar are, the *chace*, the *reenforce*, the *chamber*, the *trunnions* and their *rimbases*, the *bore*, the *dolphins*, and the *pan* (*bassinet*).

Figure of the chamber.

It has been warmly disputed which is the best form for the chamber of a mortar ; some contended for the cylindrical, some for the truncated cone, and others for the parabola. Experience having demonstrated that the powers of the cylindrical chamber were equal to those of the others, it was for a long time followed on account of its simplicity.

Gomer mortars. (PLATE IV, 2d part.)

General Gomer, a distinguished artillery officer, having discovered a chamber of greater simplicity of form, far greater range, more easily served, and in all other respects equal to the others, caused many models to be cast agreeably to his plan in 1785; and ever since his mortars have obtained over all others.

The profile of the Gomer mortar is very simple and with very few mouldings; its distinguishing characteristic is the form of its chamber, which is a truncated cone touching tangentially the cylindrical surface of the bore: the bomb, placed in the bore, rests against the sides of the chamber, and though there is often considerable empty space between the shell and the powder, the effect is not diminished. The trunnions are not on the prolongation of the cascable; their axis is in the same plane as the axis of the piece, and is fixed at about the centre of the chamber.

Several kinds of mortars. (See the Table of Dimensions.)

There are three kinds of mortars, which throw bombs of 8, 10, and 12 inches; their profiles differ in dimensions only.

The bomb.

The bomb is a concave sphere of cast iron, having an eye to receive the charge and the fusee, and two handles to handle it the easier: they weigh from 100 to 150 lbs.

Properties of the bomb.

The interior of the bomb is not perfectly spherical; it has a cup opposite the eye about 26 lines in thickness, whilst the sides are only 16 lines thick. The effect of the cup is to force the bomb to fly with the fusee towards the rear, and to greatly increase its powers of resistance and percussion.

Bombs may be fired like the howitz in *ricochet**; they bury themselves in the earth and there burst, throwing up the ruins, and scattering their fragments in all directions, firing magazines

* *Ricochet* firing, is when the angle of fire is such, that the shot glances and bounds forward. The successive bounds are numerous if the shot strike a smooth plane at a favourable angle. Shot will *ricochè* upon ice upwards of 5 miles. English military writers have introduced so many French words, which could have been more elegantly expressed in their native idiom, that many of them have taken root; and we are compelled to use them, notwithstanding that few of them have been admitted into dictionaries. There can be nothing more ridiculous than an affectation and mixture of a foreign tongue, when the vernacular language is so transcendantly laconic, energetic, and classic.

TRANSLATOR.

and quarters of towns, and breaking into magazines that are not proof: they harass the *terrepleins* of fortifications, and slaughter the troops: in fine, one of their principal properties is a curved fire, which enables us to destroy the most concealed and invisible objects.

Stone mortars. (See 2d *part* of PLATE IV and the Table of Dimensions.) Baskets of stones thrown from them.

Stone mortars (*pierriers*) are used to throw baskets of stones into the works of the besieged or upon the assailing party; they are used only at very short distances, as 30 to 40 mètres (33 to 45 yards). They are a sort of large mortar, the sides light and thin because they are fired with very small charges: the form of the chamber is the truncated cone, enlarging towards the mouth. At the bottom of the bore or entrance of the chamber, a cover of oak wood (*tapeon*) is placed, and on this the basket of stones rests. The basket is about 4 decimètres (16 inches) in depth, and contains $1\frac{1}{2}$ cubic foot of stones: a tumbril carries fifteen of them.

The grenade.

Grenades are projectiles thrown by hand into the works of the besieged when within a distance of about 30 mètres (33 yards). They are also much used by the besieged against the besiegers; they are only employed in the attack and defence of places. However in 1793, General Andréossi used them with success by loading field pieces with them, as with hollow shot.

Description of the grenade. See the following Table.

The grenade is a small hollow cylinder of cast iron, having a cup, and a vent or eye in which a small fusee is fixed to fire the charge.

TABLE

Of the Dimensions of Grenades.

	French Measure. Inches.	Lines.	Points.
Exterior diameter	3	6	0
Depth from the cup to the vent	3	1	6
Thickness of the sides	0	4	3
Thickness of the cup	0	5	3

Weight 3 pounds 4 ounces (3 lbs. 8 oz. Eng.)

Rampart grenades.

There are also rampart grenades of various dimensions, and weighing from 16 to 18 pounds.

The comminge.

The comminge, which was formerly used, is a large bomb

weighing 500 lbs. and was thrown from an 18 inch mortar, the bore of which was 27 inches long. This mortar weighed 5200 pounds, and its brass bed 3600 pounds. The comminge held 48 pounds of powder, but 12 pounds were sufficient to burst it.

Properties and defects of the comminge.

Their use was to destroy and blow up bomb proof magazines, and they were principally used in attacking forts and citadels: but their service is so difficult, slow, and uncertain, that they have been laid aside. Those that still remain in some fortresses, might be used as fougasses under glacises, and even under breaches; in 1793 we enveloped the counterscarp of the *tête-de-pont* of Cassel with a chain of fougasses made of comminges found in Mayence.

Hollow shot.

The hollow shot is an invention entirely modern, and of the advantages of which opinions will remain divided so long as accurate experiments furnish no decisive results. It is nothing more than an howitz without the cup, and in firing is attached to a wooden bottom or *sabot:* it is evident that neither its force of percussion, range, nor velocity, are equal to the solid shot.

Use of red hot shot.

Firing with red-hot shot is a late invention, consequent upon the discovery of quickly heating shot and loading the piece without danger. They are principally used to fire vessels and combustible and wooden buildings; accordingly this mode of firing is always practised in sea-coast and floating batteries. It was at first supposed that the expansion of the metal heated to red-hot, would so greatly increase the caliber of the shot as to prevent its entering the piece; but as the expansion is only 6 points, the windage is sufficient to load with facility.

Expansion of shot heated red hot.

Manner of heating red hot shot.

Grates were first used to heat shot, but were found to be dangerous, tedious, expensive, and imperfect. Reverberating furnaces were then invented, and heated with wood or coal: when the fire is once kindled in this furnace, the shot is heated red-hot in thirty minutes.

New method of firing red hot shot.

The experiments that we witnessed at Cherbourg in 1785, prove that by putting a wad of clay upon the powder and upon the red-hot shot, the gun may be pointed at leisure and without danger: shot were left to cool in the piece without firing the charge. Instead of clay, wads of hay steeped 15 minutes in water may be used. First ram over the charge a dry hay wad, then a large wet wad, then put in the shot, and cap the

whole with another wet wad. In both cases it would be well to use cartridges of thin pasteboard or parchment.

Effect, and depth to which a red hot shot sinks in wood.

We might be disposed to believe that a red-hot shot lodged in a mass of wood, would extinguish for want of air to feed the fire; and it would be well to determine this fact beyond doubt by proper experiments. In the Cherbourg experiments, where the mass of wood fired into had intervals and interstices, there was no sign of combustion for nearly six hours; but then the fire broke out and raged so furiously as to instantly consume the whole mass. By these same experiments it was found that the depth to which the hot shot penetrated, was very little less than that of the cold shot; the depth of the first being 42 inches (nearly 46 inches), and of the latter 43 inches.

Incendiary shot.

Incendiary shot are used for the same purposes as red-hot shot, and have this advantage, that they can be handed about in a vessel without danger. They are composed of iron carcasses covered and filled with combustible matter hard rammed. Their firing is very uncertain and cannot produce any effect at a distance exceeding 300 to 350 mètres (330 to 390 yards).

Such are the weapons used by the artillery forces, and which, together with the musket, and the sword and bayonet, already described, are the arms of modern warfare.

45. Modes of loading cannon (*See L'Aide Memoire* and the Artillerist's Manual.)

45. All the various modes of loading cannon are reducible to quickly and safely introducing into the bottom of the bore or chamber the charge of powder, and placing over it the mobile that is to be projected.

The charge: generally one third the weight of the shot for guns.

Tables No. 1 and 2, in the volume of plates, show the several charges of powder for throwing and bursting howitzes and bombs. Experience has established the charge for guns to be one-third the weight of the shot. This proportion gives sufficient ranges for all ordinary cases; but it is diminished when great ranges are not required, or to produce *ricochets;* and increased when greater effects are necessary.

Former mode of loading cannon.

Formerly cannon were loaded by conveying the powder to the bottom of the bore in a long handled ladle, and then covering it with the wad and ball. But this mode is no longer practised, except with heavy pieces and in slow and *ricochet* firing, where the charge is graduated according to the distance and position of the object. The great inconveniences of the ladle have been remedied by the use of cartridges.

Cartridges; and the best materials to make them of.

The cartridge (*gargousse*) is a cylinder of paper, parchment, or serge, of the same diameter as the piece, and containing the charge of powder, and covered over at the top with a wooden grooved form. Of all the substances used to make cartridges, experience has proved that the common serge, or such like woollen stuffs of straight threads, are best; the powder sifts least through them; they do not burn to coal, like paper and thread, and are sufficiently strong to bear transportation and handling.

The term *cartouche*.

The expression *round* (*cartouche*), is often confounded with cartridge (*gargousse*), though it only directly means the shot lying upon the top of the latter, and to which it is often attached.

Round and grape shot.

There are two kinds of shot (*cartouches*), round, and grape shot; the latter have grown into great use against infantry and cavalry; at short distances their effects are most murderous.

Fixing cartridges and round shot with *sabots* for 4, 8, and 12 pounders and for light troops

The *cartouche* or shot is fixed upon a bottom or *sabot* of beech wood, to which also the cartridge is attached. The *sabot* is a small cylinder of the diameter of the receiving cylinder, and about 13 lines to two inches in thickness; at the thickness of 4 lines it is grooved; on the upper side it is concave the half of its thickness, in order to receive the ball which should touch the bottom without pressing against the limb. The ball is fixed to the sabot by two thin straps of tin nailed upon the sabot, and crossing and let into each other by a slit at right angles over the shot. The lower part of the sabot is then put into the cartridge, which is tied tightly in the groove; a slip of wet parchment 5 millimètres in breadth (nearly $\frac{1}{4}$ of an inch) is then tied over the groove and immediately below the sabot, to prevent the serge from chafing where it is most exposed.

TABLE.

	12 poun'rs. ins	lines	8 poun'rs. ins	lines	4 poun'rs ins.	lines	lt. troops ins.	lines
Length of the sabot (French measure)	2	0	1	10	1	6	0	13
Depth of the concavity	0	13	0	11	0	8	0	4, 6
Length of the charge of powder . .	8	3	6	9	6	1	5	1
Total length of the cartridge . . .	13	6	11	6	9	11	7	8
Weight of the cartridge or total charge	16lb	11oz	11lb	2oz	5lb	12oz	2lb	1oz

Composition of the canister cartridge. The tin canister.

The balls used for *canister* cartridges are of three calibers; the *best* are those made of wrought iron. The balls are contained in tin canisters calibered by moulds; at the bottom is soldered a circle of sheet iron which, together with two small bands of the same metal, sustain the cast or wrought iron cup (*culot*) upon which the balls rest. The top of the tin canister is scalloped, and is beaten down upon the lid of sheet iron that covers the shot. Hence in the round of canister there are four parts; the tin canister, the cup, the cover, and the grape shot.

Flat and concave cups of cast or wrought iron.

Experience, confirmed by reason, proves that when the balls rest upon an iron bottom or cup they receive the greatest impulsion; and that the *culot* greatly contributes to increase the range, and diminish the divergency, of the shot.

Formerly the cups both for howitzers and guns were flat; but it was observed and proved that the concave cast iron cups increased the range of the shot, and they were accordingly adopted both for cannon and howitzers; this cup is fixed to the bottom of the canister by the circle of sheet iron and the two bands mentioned. The sheet iron covers of canisters for 24, 16, and 12 pounders and howitzers, have handles. For 4 pounders and howitzers, the canister is fixed to the cartridge, and the tin is nailed to the sabot, which being concave, receives the culot as it would the ball.

Small and heavy canister shot. (See all the details in *L'Aide Memoire*, page 523)

We have said there were grape shot of three calibers or numbers; the first forms the heavy canister, and the second and third the small canister. The following table will complete our sketch:—

TABLE

Of Canister Shot.

	12 pounder.			8 pounder.			4 pounder.			6 inch howitz.		
	ins.	lins.	pts.	ins.	lins.	pts.	ins.	lins	pts	ins.	lins	pts.
Diameter of balls No. 1, or heavy grape shot	1	5	0	1	2	9	0	11	10	1	5	0
Diameter of balls No. 2, or small grape	1	0	0	0	10	6	0	10	9	0	0	0
Diameter of balls No. 3, or smallest grape	0	11	6	0	10	1	0	0	0	0	0	0
Interior diameter of the canister, cup, and cover	4	3	0	3	8	6	2	0	0	5	10	0
Thickness of the cups (*culots*)	0	3	6	0	3	0	0	2	6	0	4	0
Length of the charge of powder	12	0	0	11	0	0	10	0	0	10	0	0
Exterior length of the canister of large grape	8	3	0	6	9	0	5	7	0	7	4	0
Exterior length of the canister of small grape	7	6	0	6	8	0	6	6	0	0	0	0
Number of balls No. 1, in the large canister	41 balls.			41 balls.			41 balls.			60 balls.		
Number of balls in the small canist. of No. 2	80b			80b			No. 1	4				
Number of balls in the small canist. of No. 3	32b		total balls 112	32b		112	No 2	59	63			
Weight of the empty canister and cup	1 lb	12 oz		1 lb	9 oz		14 oz					
Weight of the culot or cup	1	5		..			6 oz	6 gr				
Number of covers (*couvercles*) to the pound	10 covers.			..			26 covers.					
Weight of the large canister	20 lb	4 oz		14 lb	6 oz		7 lb	8 oz		32 lb	8 oz	
Weight of the small canister	20	4		14	7		8	9				
Price of the sheets of tin	15 sous.			9*s*	6*d*		9*s*	6*d*				

N. B. The sous is nearly equal to a cent.

By such means the service of loading cannon and howitzers is rendered simple, speedy, and perfectly safe. That of mortars and stone mortars is also easy, for they are fired slowly and carefully; the piece is raised in a vertical position, and the powder poured into the chamber and slightly rammed; the bomb is then placed in the bore and kept steady by four slips of wood. In the stone mortars, a circular bottom of wood is placed over the powder, with the basket upon it.

Loading of mortars and stone mortars.

46. Having described cannon and the mode of loading them, we will next briefly speak of the means of bringing them into action, and giving them the mobility requisite in the various modes of combat. This never could be accomplished until the piece

46. Mode of manœuvring and provisioning the artillery. (PLATE V.)

was manœuvred in the same manner as the soldier handles his musket; and it is to art and invention that we owe this great improvement. So long as these means were not discovered or improved to a certain degree, it was impossible that artillery should have much influence in battle; it was therefore more a source of terror than destruction.

Gun carriages and wagons used in the artillery.

The invention of gun carriages (*affûts*), by which even the heaviest guns are sustained and manœuvred, must have followed close upon that of cannon; the various kinds of carriages and wagons used in the artillery were successively and gradually invented.

Gun carriages fit for all services.

For a long time there was only one kind of gun carriage known, the construction of which possessed many of the following essentials, viz:

1st. The carriage should permit the recoil of the piece, so as not to be soon destroyed.

2d. It should be sufficiently light and moveable to be easily manœuvred.

3d. It should allow the piece to be pointed within certain angles around its axis.

4th. It should be able quickly to assume its travelling form, to change position, or take up the line of march.

All these essentials were possessed by the old carriage, which was gradually perfected, and adopted for the howitzer.

Garrison and sea coast carriages.

Garrison and sea coast carriages are a modern invention, as are those of Montalembert and of many other officers, who have studied to adapt them as much as possible to casemates: three men can manœuvre this kind of carriage. The characteristics of these carriages are to elevate the piece above the crest of the epaulment, and, what is a great advantage, avoid the necessity of embrasures. As garrison carriages are liable to be transported from place to place, they are mounted on wheels for travelling; but the sea coast carriages never being removed, are merely mounted upon cylinders.

(See *Le Manuel de L'Artilleur*, and *L'Aide Memoire*.)

We will not enter into the details of these latter carriages; they require particular study, and are within the province of the schools of practice. We will limit ourselves to describing the common carriage, the form of which is simple and necessary to properly understand firing: all other carriages are but modifications of this.

Description of the common carriage. (See PLATE V, and the Table.)

The common carriage used for field and siege artillery, is composed of two principal pieces called the cheeks (*flasques*), joined together by 3 or 4 pieces called transoms (*entretoises*), imbedded in the cheeks about 9 lines, and traversed by iron bolts with screws and nuts with rundles. On the fore part of this solid body and immediately between the cheeks, the cannon or howitzer rests upon its trunnions which are let into the cheeks, preserving however the power of rotation. Beneath this fore part, a wooden or iron axle-tree is let into the cheeks, and which by means of two wheels lifts this part of the piece, whilst the hind part or extremity, called the *trail* (*la crosse*), rests upon the ground.

Placing of the transoms.

The transoms are situated for the purpose of solidity, firing, and manœuvre; in siege carriages it is necessary that they should allow a depression of 7 to 8 degrees below, and 15° above, the horizon; in field pieces they are so placed as to permit a depression of 15, and an elevation of 17 degrees.

Placing the trunnions and axle-tree.

It is desirable that the trunnions should be placed as near as possible to the front of the carriage, but the adjacent parts must be of proper solidity; and the axle-tree, situated near the vertical plane that cuts the rear of the trunnions, must be strong enough to sustain the shock of the recoil. The axle-tree is thus placed a little in rear of the vertical plane that cuts the rear of the trunnions, in order that the trail may be neither too light nor too heavy. If it were too heavy, it would be difficult to lift in the manœuvres; if too light, it would be difficult to place the piece in a given position for firing.

Names of the transoms of siege carriages;

Siege carriages have four transoms, called the *chace* transom (*entretoise de volee*), the *breech* transom (—— *couche*), the *pointing* transom (—— *mire*), and the *trail* transom (—— *lunette*); between the breech and pointing transoms, there is a dove-tailed plate in which the pointing screw is adjusted.

Of howitzers;

The transoms of howitzer carriages are, the *chace*, *breech*, *supporting* (—— *support*), and *trail* transoms.

Of field pieces;

The carriages of field pieces have only three transoms; the *chace*, the *supporting*, and the *trail* transoms, and a pointing plate (*semelle mobile*). Between the chace and supporting transoms, there is a pointing screw with an iron worm, to raise the pointing plate attached to the chace transom.

Of pieces for light troops.

The carriages of pieees for light troops have, ehaee, breech, and trail transoms.

Form of the trail.

Siege carriages have the trail cut square, beeause they are used on platforms ; but the trails of field pieees are much rounded, beeause they are dragged along the ground eonsiderable distanees and over natural obstacles.

Traciog the carriage and its vertical and horizontal projectioos.

The pointing centre.

Carriages are traeed agreeably to the rules and dimensions laid down in the artillery tables, whieh are the result of experience. The pointing eentre (*cintre de mire*) is the eut made in the cheeks of the earriage, dividing the front from the rear part. The tables give the length of the cheeks, their depth in front and at the pointing centre and trail ; the dimensions of the transoms, &e.

Travelling — notches for the trunoions, in all field pieces above 4 pounders.

We have already said, that when a pieee is in battery, its whole weight rests upon the wheels ; eonsequently the vertieal that euts the eentre of gravity, almost euts the axis of the axletree. If this were suffered to be the case when in march (*en route*), the wheels would soon break down ; therefore the travelling notches or grooves for the trunnions were made, and in these the piece rests in march. By this arrangement, the pressure of the weight is divided between the wheels of the earriage and of the limber (*avant train*), or in other words the load is earried upon four wheels. Four-pounders are too light to require these travelling trunnion plates ; and as battering pieees do not travel on their earriages, they have not double trunnion notches.

The depth of these notehes is two-thirds of the diameter of the trunnions.

(See PLATE V, and its explaoations, and following Table.)

To give some idea of the traeing of a gun carriage, we have merely added at the end of the explanation of Plate V, a table of the neeessary dimensions for the profile and plan of a 12 pounder field carriage.

The pointing screw, aod copper out.

Formerly all earriages had pointing transoms (*entretoise de mire*), on whieh eoins or wedges were plaeed to give the necessary elevation in firing ; but at present the pointing screw with square threads turning in a eopper nut, is adopted in all earriages.

In field earriages, the nut is fixed in a revolving iron cylinder, by turning which the gun rests upon the supporting transom. In battering pieces the nut is lodged in the pointing

plate. The iron work of carriages is very heavy, and is upon the wheels, axle-tree, body of the carriage, &c.

Iron work of gun carriages. (See the details in *L'Aide Memoire*.)

The limber (*avant train*) is a sort of cart with a working pintle, which is passed through the eye (*lunette*) of the trail transom, and thus converts the whole into a four-wheeled carriage for route or manœuvre.

The limber.

When in presence of the enemy and changing position only, the piece is often manœuvred with the prolonge; this method is very advantageous, especially for horse artillery. The limbers of field pieces have poles, which facilitate and quicken the manœuvres, and lessen the depth of the columns. The limbers of battering pieces have shafts. For more particular details we refer to the "*Aide Memoire*," and "*Manuel de l'Artilleur*."

The principal carriages that follow the movements of troops and artillery, are, the ammunition caissons containing cartridges, &c. for immediate use. There are seven kinds of caissons, differing only in their interior arrangement and division; except that the 4 pounder caisson is 18 lines less in depth than those for other calibers.

Ammunition caissons, and other wagons used in the artillery.

The exterior length of the caisson is 9 feet 1 inch 3 lines, and it is 18 inches broad, and 12 inches deep, exclusive of the gable of the lid, which is 7 inches deep.

All caissons have limbers; their pintle bolt passes through the front of the caisson and thus makes it a four-wheeled carriage. The 4 and 12 pounder caissons are also fitted to transport musket cartridges; the former following the infantry and containing 15,935 rounds, and the latter remaining in the park contains 16,335 rounds, of 18 balls to the pound. The limber box (*coffret*) is a small chest with handles, to contain ammunition; it is lodged between the cheeks of the carriage, and is always filled; it is used to fetch cartridges from the caissons when they are a little distant from the pieces.

The limber boxes.

Every 12, 8, and 4 pounder and howitzer caisson is divided transversely into four great divisions, and these are sub-divided into compartments containing cartridges, cartridge bags, howitzes, and other supplies. We must again refer to the *Aide Memoire*, by General Gassendi, wherein all these details are fully and clearly illustrated.

Divisions and compartments of caissons. (See *L'Aide Memoire*, page 216 and the following.)

TABLE

Of the Contents of Limber Boxes and Caissons.

	Limber boxes.	Caissons.		Total No of rounds for each piece
For 12 Pounders.				
Rounds of shot or ball . . .	9	48		
——— of large canister . .		12	68	
——— of small canister . .		8		
Three caissons to each piece .			204	213
For 8 Pounders.				
Rounds of shot	15	62		
——— of heavy canister . .		10	92	
——— of small canister . .		20		
Two caissons for each gun . .			184	199
For 4 Pounders.				
Rounds of shot	18	100		
——— of heavy canister . .		26	150	
——— of small canister . .		24		
One caisson for each gun . .			150	168
For 6 inch Howitzers.				
Rounds of howitz or shell . .		49	52	
——— of heavy canister . .	4	3		
Three caissons to each howitzer				160
Boxes (Coffrets), for light troops.				
Two boxes to each piece, each containing 40 rounds . . .				80

Wurst-caissons.

The *wurst-caisson* is smaller than the common caisson, and carries the ammunition for the guns of the horse artillery.

The body of the caisson is hung, and its lid or top is rounded and covered with leather, in order to carry the wounded or dismounted.

There is a difference between the wurst-caisson for 8 pounders, and for howitzers; both are divided transversely into four divisions, and these into cases or compartments for the ammunition; but that for the 8 pounder holds 66 rounds, whilst the howitzer caisson contains only 30. Caissons are also used to transport tools and implements for the companies of artificers and workmen.

Implement caissons.

Ammunition wagons.

Ammunition wagons (*chariots de munitions*) are four-wheeled carriages, used for transporting fresh or spare pieces, pioneers' tools, &c.

Carts used in sieges.

The cart is on two wheels; there are *three* different kinds, distinguished by their length. The first is made to contain

six tuns of powder of 200 lbs. each; likewise to carry tools. The second is not so long, and is used to transport ammunition to the trenches. The third kind is only used to carry bombs and cannon balls.

The *camion* is a two-wheeled cart for transporting the beds of heavy mortars, and the mortars also, when required. The camion.

The cannon wagon (*chariot à canon*) is two pair of wheels united by two shafts, to carry heavy cannon, mortars, and stone mortars. The cannon wagon.

The sling cart (*triqueballe*) is a kind of limber with a tongue, having wheels 7 feet in diameter, and the pole or tongue 14 to 15 feet long: it is a lever of the greatest power, and is used to move heavy bodies. Sling carts.

There is at present but one kind of travelling forge (*forge de campagne*), which is on four wheels. Travelling forges

The *haquet* is a four wheeled carriage with two shafts, rests, and brackets, &c. to transport pontons, boats, and small beams, for making bridges. The haquet for pontons, boats, skiffs, &c. (See *L'Aide Memoire*, and *Manuel de L'Artilleur.*)

Such are the carriages used in the artillery: a description of them is not within the limits of a general Treatise; we therefore refer to "*L'Aide Memoire*," and the "*Manuel de L'Artilleur.*"

Mortars and stone mortars have beds suited to their nature. These pieces being fired under great angles of elevation, their carriages sustain very great shocks; hence they should be horizontal, well laid, and supported by very solid platforms. These beds are of a very simple form; they are two cast iron cheeks of the figure of an inclined plane, and their configuration in the length is peculiar, with mortises for the trunnions, catch (*mentonnet*), &c. The two cheeks are united by two wooden transoms likewise of the figure of inclined planes, each traversed by two or three connecting iron bolts with screws, nuts, and heads; each transom has also two projecting manœuvring *tenon* bolts, whereby the bed is moved. The trunnion cushion (*coussinet*), the pointing wedge (*coin de mire*), and the bolsters (*cales*), together with the quadrant, enable and facilitate the adjusting and pointing of the mortar under any given angle. The angles of the transoms are so cut, that the mortar may be turned and rest either upon the hind transom, or cushion (*coussinet*). Beds of mortars and stone mortars (See PLATE IV, 2d part.)

There are beds (*affuts*) of three numbers:

No. 1, for 12 and 10 inch mortars of great ranges.

No. 2, for 10 inch, short ranges, and for stone mortars.

And No. 3, for 8 inch mortars.

Bed No. 1 covers a square space	in length 150 centimètres	(about 60 inches).	
	in breadth 80	do.	(.. 32 ..).
Bed No. 2 and 3 do. do.	in length 134	do.	(.. 53 ..).
	in breadth 72	do.	(.. 28½ ..).

		French.
Weight of bed No. 1.	The two cheeks	2271 lbs.
	The two transoms	308
	Cushion, pointing wedge, & 2 bolsters	56
		2635 lbs.
Weight of bed No. 2.	Cheeks	1523 lbs
	Transoms	246
	Coussinet, &c.	50
		1819 lbs.
Weight of bed N. 3.	Cheeks	718 lbs.
	Transoms	118
	Coussinet, &c.	35
		871

Plaque mortars: The *plaque* mortars, together with their beds, are cast under an angle of 45 degrees (ancient division of the circle): they are not used in France, but are common in foreign armies. Their ranges are very great, being graduated by the quantity of powder in the charge. Perhaps if this method were generally adopted for mortars of all calibers, it would be more advantageous than the present mode, and produce greater accuracy of firing*.

Their properties.

Cannon implements. (See *L'Aide Memoire*, and *Le Manuel de L'Artilleur.*)

Cannon implements (*armement des bouches à feu*), means the necessary instruments and fire-works for manœuvring and firing. These are, the linstock (*le boute feu*), the port-fire-stock (*porte-lance*), the ladle (*lanterne*), the rammer (*le refouloir*), the spunge (*ecouvillon*), the priming wire (*dégorgeoire*), the worm (*tirebourre*), the hand-spikes (*les leviers*), &c. the quadrant, the water bucket (*auvette*), the slips or bomb-wedges (*les eclisses ou coins de bombes*), &c. and the slow-match (*la meche*), the

* If this method were adopted, the mortar could no longer be used for *ricochè* firing: the angle of fire would be too great to produce *ricochès*.

TRANSLATOR.

quick-match (*etoupille*), the priming fusees (*fusée d'amorce*), the port-fire (*la lance à feu*), &c. All these are so well known, that we will not attempt to describe them.

What we have said on mortars and stone mortars and their beds, together with the drawings and models before us, suffice to complete the general description of these arms, and to prepare the students for a more minute study of them in the schools of practice.

Dimensions of wagon beds, and of axle-trees.

We will conclude this article with some of the dimensions of wagon beds (*voies de voitures*), and the length of axle-trees.

	French. inches.	lines.		*English.* ins.	lines.
Common bed of artillery wagons . . .	56	6	=	60	6
Bed of wagons used in garrisons	45	0		48	2
Length of the wooden axle-trees of battering pieces	85 to 72 in.			91 to 77 in.	
Length of the axle-trees of carts	78	4		83	8
Length do. of 12 pounders .	77	4		82	8
Length do. of 8 pounders .	77	1		82	6
Length do. of 4 pounders .	73	7		78	9
Length do. pieces for light troops	58	6		62	7

Axle-trees are of five numbers: viz. No. 1, 2, 3, 4 and 5.

Weight of No. 1 . 236 lbs. Weight of No. 2 . 214 lbs.
do. 3 . 151 lbs. do. 4 . 183 lbs.

These details are useful to determine the breadth of lines of communication in fortification, and in reconnoitring roads preparatory to the march of columns.

47. Theory and doctrine of gunnery, and the phenomena upon which it depends.

47. All the machines and implements that we have hitherto described, are for the single purpose of easily and rapidly firing artillery; this consists in giving the mobile such a direction as to strike a given object. The theory of gunnery has for basis two of the remarkable phenomena of nature; the first, in chymistry, relates to the spontaneous inflammation of powder; and the second, in mechanics, is the laws which govern the motion of a projected body influenced by gravitation.

Phenomenon of ignited gun-powder, and the power that it produces in the bottom of the bore.

The ignition or combustion of powder is a phenomenon in chymistry producing spontaneously several kinds of elastic fluid, and so ardent a heat, that the expansion is capable of producing the most astonishing and awful effects. Its force may be estimated, according to circumstances, at 30 to 80 thousand times the pressure of the atmosphere; accordingly, if we suppose the phenomenon to take place in the bottom of the bore of

a gun loaded with a projectile, and all the surrounding parts (except in the line of the axis) firmly resisting, it is evident that the mobile will be impelled into motion by great forces acting in the direction of the axis.

Initial velocity of the mobile.

The *initial velocity* of the mobile, is that with which it leaves the muzzle of the gun at the instant when the expansive forces of the powder cease to act upon it, and it is left to the impulsion of forces considered mechanical. Consequently the effect of the forces of the powder is to impart to the mobile a certain initial velocity.

Nature of the forces of powder, and its mode of action until the moment of explosion.

We will suppose that the length of the bore is indefinite, and that there is neither windage nor friction of the mobile against the sides: this being granted, we would observe that the inflammation of the powder, although very rapid, is not instantaneous, because this concrete body must pass into the state of an elastic fluid through a liquid state, and as each grain of powder takes a certain time to burn from the surface to the centre. In either case the effect would be very different; in the first, the mobile is put in motion by the whole force; in the second, the mobile is urged into motion by the successive inflammation, and when in motion receives degrees of velocity proportioned to the portions successively ignited, and which impart to it a final velocity that must very sensibly differ from that acquired in the first case. This second hypothesis grants that the whole quantity of powder takes fire before the explosion, and consequently that the length of the bore is indefinite. The force of the powder therefore acts, 1st, like an impulsion that overcomes the inertiæ of the mobile and the pressure of the atmosphere; 2d, like an increasing accelerating force, acting against the mobile, and constantly increasing its velocity to that point at the extremity of the gun where the elastic fluid becomes in equilibrium with the atmospheric pressure: if this point be the muzzle of the piece, then the initial velocity is the maximum; if the bore be shorter, the initial velocity will not have received all its degrees of force; and if the length exceed this point, the velocity will decrease from the pressure of the atmosphere, which would then exceed the force of the elastic fluid.

Important deduction in relation to initial velocity.

From the manner in which the powder acts upon the mobile, it must be, 1st, that the initial velocity of the same charge increases in proportion to the length of the bore, to a very distant limit; 2d, that for the length of the bore, determined

and included within the limit of which we speak, there must exist a particular charge calculated to produce the greatest initial velocity of each caliber.

'Tis obvious that it is only by a series of experiments made with the greatest care and most perfect models, that we can assure ourselves of the accuracy of the deductions which appear to result from theory, and establish the degrees of precision and limits of these deductions.

Experiments upon which the theory is founded.

Many celebrated and learned men, and among them, D'Arcy, Borda, and Robins, have devoted much study to this interesting subject; but it is to Charles Hutton that we are indebted for the most complete and extensive course of experiments, the best calculated to confirm the important doctrines of the theory.

(See Doctor Hutton's work.)

48. Charles Hutton investigated the subject in its true light, by striving to ascertain the force and effect of the powder by the initial velocity of the mobile, and examining the various modifications to which this velocity is subject in its different stages. The experiments by which the initial velocity has been hitherto determined, were made by various mechanical means, to obtain the data requisite to the analysis and knowledge of it.

48. Ascertaining the force of powder by the initial velocity.

The different methods used to ascertain the initial velocity of the mobile.

The first method is by suspending the piece by an iron bar or ring, whose direction cuts the centre of gravity of the cannon; the bar is attached to an horizontal axis turning perfectly easy, and with the least possible friction: the axis of the gun is horizontal, and the whole forms a compound pendulum, which oscillating by the re-action of the shock of the powder, affords the means of calculating the initial velocity.

First method, by the recoil of the cannon.

The second method used by Robins, is by firing against a wooden pendulum having on the rear side an iron plate, and about 11 mètres (12¼ yards) distant from the muzzle of the piece; the measure of the arcs of oscillation determines the velocity of the mobile at the moment of the shock. But as the mobile meets with resistance from the air before it strikes the pendulum, the determined velocities must be rectified by increasing that of small charges one-fortieth, that of medium charges one-thirtieth, and that of the heaviest charges one-twenty-fifth. Hutton used the two methods at the same time, to compare the results and give them the greatest exactness. We will here give the two formulæ for calculating the velocity by either method.

Second method by the ballistic pendulum.

To calculate the initial velocity of the shot by the recoil.

To calculate the initial velocity by the recoil of the piece, we will hypothecate as follows:

Let P=the weight of the piece, and of the iron bar or ring that supports it.

.. p=the weight of the shot or ball.

.. b=the distance from the centre of gravity of the whole, to the axis of rotation.

.. a=the distance from the axis of the bore, to the axis of rotation.

.. E=the distance from the centre of oscillation to the axis of rotation.

.. θ=the angle described in the first half oscillation determined by experiment.

These being granted; and as the action of the powder tends to impel the piece in an opposite direction to that of the projectile, then from the nature of oscillation we have the momentum of the quantity of motion in the piece=$P\,b\,E\,v$ (v being the velocity of the point of intersection of the bar or ring prolonged to the axis of the gun). We have likewise the momentum of the quantity of motion of the shot=$p\,a\,V$ (V being the initial velocity of the shot). But the forces of the expanding fluid acting in all directions, produce a *re-action* equal to the action; therefore we have $P\,b\,E\,v=p\,a^2\,V$.....(a). And we find for the velocity of the centre of oscillation of a body turning upon an axis and departing from the lowest point, $\sqrt{2\,g\,E\,(1-\cos.\,\theta)}$; but as v is the velocity of the axis, that of the centre of oscillation will be given by the proportion $a : E :: v : \frac{E\,v}{a}$; consequently $\frac{E\,v}{a}=\sqrt{2g\,E\,(1-\cos.\,\theta)}$ (b). If C be the chord of the arc described by the radius R; then we find by this hypothesis *vers. sine.* $\theta=\frac{C^2}{2R}$; and for the radius R, *vers. sine.* $\theta=\frac{C^2}{2R^2}$; and because $1-cos.\,\theta=vers.\,sine.\,\theta$, the equation ($b$) becomes .... $\frac{E\,v}{a}=\frac{C}{R}\sqrt{g\,E}$: substituting in the equation (a) for v its value $v=\frac{a\,C}{E\,R}\sqrt{g\,E}$; we shall thence deduce the value of the initial velocity $V=\frac{P\,b\,C\,\sqrt{g\,E}}{p\,a\,R}$.

To calculate the initial velocity of the ball by the oscillation of the pendulum.

To calculate the initial velocity by the pendulum, let us suppose M=the body of the pendulum.

m=the body of the shot.

b=the distance from the centre of gravity of the system of the shot and pendulum, to the axis of rotation.

a=the distance of the centre of gravity of the body of the pendulum to the axis of rotation.

E=distance of the centre of oscillation of the pendulum, to the same axis.

E'=distance of the centre of oscillation of the pendulum and shot, to the same axis.

V=initial velocity of the shot.

ϱ=distance of the shot to the axis of rotation at the moment of impact.

ω=angular velocity of the pendulum at the end of any given time t.

θ=angle described in the time t, and determined by experiment.

These being established; then, when the shot strikes the pendulum it imparts to it an initial velocity equal to $\frac{m V \varrho}{m \varrho^2 + M a E}$: as the pendulum is supposed to be in a vertical position, let Ω stand for its velocity, and we find: $\omega^2 = \Omega^2 - \frac{2 g}{E}(1 - cos.\ \theta)$.....$(a)$; if we assign this initial velocity to the shock of the ball, then must $\Omega = \frac{m V \varrho}{m \varrho^2 + M a E}$: substituting this value in the equation (a), by putting for $\frac{2 g}{E}$, $\frac{2 g}{E'}$, because when the shot strikes the pendulum, it becomes part of the system: we find $\omega^2 = \frac{m^2 V^2 \varrho^2}{(m \varrho^2 + M a E)^2} - \frac{2 g}{E'}(1 - cos.\ \theta)$; but at the end of the half oscillation we find $\omega = 0$; which gives $V^2 = \frac{2 g (m \varrho^2 + M a E)^2}{m^2 \varrho^2 \times E'}(1 - cos.\ \theta) = \frac{2 b g (M + m)(m \varrho^2 + M a E)(1 - cos.\ \theta)}{m^2 \varrho^2}$, by substituting for E' its value $\frac{m \varrho^2 + M a E}{(M + m) b}$. And if we substitute the

weights P and p, for the masses M and m, we will find $V = \frac{\sqrt{2\,b\,g\,(P+p)(p\,\xi^2 + P\,a\,E)(1-cos.\,\theta)}}{P\,\xi}$: an expression that will give the value of V, when we have found the angle θ by observation.

Third method to determine the initial velocity of bombs and howitzes. (See Hutton's Essays on Mechanics.)

We can determine with sufficient exactness the initial velocity of a bomb or howitz by firing the mortar or howitzer in a vertical direction and measuring by a pendulum vibrating seconds, the length of time from the explosion to the fall of the shot; and this will furnish sufficient data to calculate the initial velocity. Although this problem may be determined, nevertheless it contains analytic difficulties, the examination of which would carry us far from our immediate subject.

Methods of proving the strength of powder, before receiving it.

There are three methods in practice to try the strength of powder before receiving it. The first method used by the Chevalier D'Arcy, is the eprouvette fixed in the compound pendulum: the strength and quality of the powders are determined by the recoils of the same charge. This method also illustrates the doctrine of the recoil in respect to different charges of the same powder. The second method, and that which is now only used, is by firing out of the eprouvette (a sort of mortar 7 inches in diameter), under the angle of 45 degrees, a globe of 60 pounds weight, by the range of which the strength of the powder is found. With a charge of 92 grammes or 3 oz. $5\frac{3}{8}$ grains (2 oz. 19 dwt. 4 grs. troy Eng.), the range of the globe should be 200 mètres (223 yards) to prevent the powder being rejected: formerly 3 ounces of powder threw the shot only 90 toises (195 yards).

This mode of trying powder, and comparing it with a powder whose strength is already known by the eprouvette pendulum, is simple and efficient. The weight of the mobile, and the little velocity that is imparted to it, render the resistance of the air so inconsiderable that it may be considered equal at each trial or shot.

48. Labours and experimeots of Hutton to determine the principles of practical gunnery. (See Doctor Hutton's work, with the importaot notes of Col. Villantroys of the artillery.)

48. The most important researches and experiments that have been undertaken to obtain results on which to found the ballistic theory, are those of Hutton during the years 1783, '84, '85, and '86. This learned author made his experiments with an artillery much heavier than that used by his predecessors; and he determined the effects at the same time by the recoil of

the piece in the compound pendulum, and by the oscillations of a pendulum struck by the mobile.

The artillery used by Doctor Hutton.

Doctor Hutton made his experiments with 5 cannon that were founded at Woolwich with the greatest possible care and of the caliber of one pound English (0.453 kilogramme), with different lengths of bore. The diameters of the shot were between 1 inch .9, and 1 inch .97 English, (equal to 0.483 decimèt. and 0.5 decim.): the diameters of all the shot were then made equal to the mean 1 inch .96 (0.498 decim.), and their weight to 16 oz. 88 (851.6 gr.): the windage therefore was very little; it was not 0.2 millim's ($\frac{1}{125}$ of an inch Eng.). The powder used was of a good quality and uniform, and strong enough to throw the globe at least 200 mètres (225 yards). The cartridges were made of flannel; and twisted thread was wound round the shot to make them fit tight in the bore.

The following table exhibits the principal dimensions of this artillery :—

Number of the piece.	Length of the whole piece.	Length of the bore	Diameter of the bore	Length of the bore in calibers	Weight of each piece.
	dt.	dt	dt.		Kilogramme.
1	7.696	7.163	0.513	13.96	131.37
2	10.249	9.677	do	18.86	130.717
3	15.24	14.572	do	28.4	133.635
4	21.057	20.295	do	39.55	179.262
5	20.955	20.439	do	39.83	227.406

The English pound=0.453 kilog. and contains 16 ozs. and one oz.=16 drachms.

The English foot=3.049 dt. and contains 12 inches of 10 lines.

First experiments by recoils, with a charge of powder only, and then with the shot

Deductions from firing with charges of powder only.

The first experiments of Hutton were to investigate the doctrine of recoils with charges of powder only, and with charges of ball; from them he drew many important deductions.

The results of experiments with a charge of powder only, invariably proved; 1st, that in the same piece the recoil increases with the charge and in a greater ratio than it, to a certain limit, beyond which its ratio becomes less than that of the charge; 2d, that for different calibers with the same charge, the recoils increase with the length of the bore; 3d, that in

short pieces with small charges, the ratios of the recoils are greater than in long pieces; but in the former by increasing the charge, the ratio more rapidly attains the limit beyond which it becomes less than that of the charge; because in short pieces, all the powder over a certain quantity does not inflame; whereas in long guns, the greatest portion of the powder is ignited.

Deductions from firing with ball cartridge.

The experiments made with ball cartridges shewed; 1st, that the recoils are much greater than with blank charges, being from the smallest to the largest charges, 4 to $3\frac{1}{2}$ times greater: 2d, that the ratios of the recoils are always less than those of the charges, and in the same piece go on in a decreasing ratio from the small to the heavy charges: with small charges, less than half the weight of the shot, the ratios of the recoils very nearly equal those of the charges: 3d, that the recoil with the same charge in different lengths of bore, increases with the length of the bore; but with small charges the ratios of the recoil are greater, and are in a decreasing ratio to the heaviest charges.

The initial velocity found by Doctor Hutton by the recoil and the impact of the pendulum.

Having thus by experiments discovered the doctrines of the recoils produced by blank and ball cartridge, Doctor Hutton next investigated the initial velocity, and attempted to find whether the action of the powder on the oscillating cannon is really the same with the two kinds of charges: which is the same as finding whether the difference of the chords of the recoils produced by firing blank and ball cartridge, is occasioned by the motion impressed upon the shot. If this be the case, the velocity of the mobile, deduced from the difference of the chords of recoil, should equal that found by the oscillations of the pendulum; taking care to rectify this latter velocity for the resistance of the body of air between the mouth of the cannon and Robins's pendulum.

After a great many experiments from which the doctor deduced the mean results, he calculated the velocity of the medium shot (1 inch .96 in diameter, and weighing 16.88 oz. Eng.) by both the recoils of the cannon and oscillations of the pendulum; and compared the velocities furnished by each.

The following table exhibits some of these interesting results, and will enable the students to form some idea of the initial velocity impressed upon mobiles by progressive charges of inflamed powder in different lengths of bore.

TABLE

Of Comparative Initial Velocities, determined by the Recoil of the Piece and by the Ballistic Pendulum.

No. of the gun.	With a charge of 2 oz. (56 gr. 6)			With a charge of 4 oz. (113 gr. 2)			With a charge of 3 oz. (226 gr. 4)			With a charge of 16 oz. (452 gr. 8)		
	Velocity, by the		Difference.	Velocity, by the		Difference	Velocity, by the		Difference.	Velocity, by the		Difference.
	Recoil.	Pendulum.		Recoil.	Pendulum.		Recoil.	Pendulum		Recoil.	Pendulum	
	d't	d't.	d't	d't	d't	d't	d't	d't	d't	d't	d't	d't
1	2530.67	2195 28	335.39	3460.62	3353.9	107.53	4405.81	4360.07	45.74	4100.9	4198.47	—98.38
2	2631.39	2545.92	85.37	3667.95	3697.8.	70.13	4637.53	4817.42	—179.89	4527.77	5049.14	—521.37
3	2802.03	2805.08	—3.05	3945.41	3963.7	—18.29	4972.92	5457.71	—484.79	5122.32	6091.9	—968.77
4	2832.52	2957.53	—125.01	4015.53	4177.13	—161.60	5088.78	5915.06	—826.28	5274.77	6421.19	—1146.42

RATIOS OF THE VELOCITIES.

	Cannon No. 1.			Cannon No. 2.			Cannon No. 3.			Cannon No. 4.		
Ratios of Velocities by the Recoil.	1.367	1.274	0.931	1.394	1.264	0.976	1.408	1.260	1.030	1.417	1.267	1.037
Ratios of Velocities by the Pendulum.	1.410	1.300	0.965	1.413	1.339	1.054	1.413	1.377	1.173	1.422	1.412	1.088

NOTE.—The decimètre is very nearly 4 inches English.

Comparison of the results and consequences.

By comparing the results in the preceding Table, it will be seen that the velocities calculated by the differences of the chords of the recoils, and by the oscillations of the pendulum impacted by the mobile, do not agree: this induced Doctor Hutton to believe that the effects of the powder are not the same with ball, as without ball. We may remark, that the differences between the velocities observe no proportion either with the same charge in different cannon, or with different charges in the same gun. But we must attend to the following consequences:

1st. There is for each piece a *particular charge* with which the two velocities are equal; and though in piece No. 4, the differences are all negative, nevertheless this charge exists, but it is less than two ounces.

2d. By the recoil, the velocity of each piece with small charges exceeds that by the pendulum; but beyond the charge producing the same velocity, the velocity by the pendulum surpasses that by the recoil in proportion as the charges are heavier.

3d. The charge to obtain the same velocities, is different in each length of bore; and the greater the length of bore, the sooner the velocities equalize, and the smaller is this particular charge: thus for example in No. 1, this charge is between 8 and 16 ounces; whilst for piece No. 2, it is between 4 and 8 ounces; in No. 3 it is 2 ounces; and for No. 4 it is between 1 and 2 ounces.

The ratios of velocities exhibit; 1st, That they are much smaller than those of the charges, and that they are in a decreasing ratio in the same piece in proportion as the charges are increased: 2d, That the same ratios for the same charges in different pieces, are greater in long than in short pieces.

Deductions from the initial velocities to make them correct and uniform.

To complete the definitive Table of mean inital velocities that we have just given, Hutton had to make two kinds of corrections to each particular experiment: 1st, The correction necessary for the weight of the shot when it differed from the mean weight 16.88 ounces. 2d, The rectification for the difference of windage when the diameter of the ball differed from the mean diameter 1.96 inch.

Correction for the weight of the shot.

The first was made pursuant to the principle, that the velocity varies in the inverse proportion of the square root of the

Correction for the difference of windage.

weight of the ball, &c. The correction for the difference of

windage is a very delicate operation, requiring experiments carefully made and frequently repeated. Hutton selected from among his experiments those which he thought afforded the least equivocal results: we will annex a table of them; they were made with the piece No. 3.

TABLE

Of Experiments to find the Diminution of Velocity, caused by the difference of the Windage.

(These are English Measures.)

Cannon No. 3.	Ball		Velocity of the Shot, in	
Charge	Weight	Diameter	Feet	French Decimètres.
Ounces	Ounces.	Inches.		
4	15.12	1.87	1225	3735.03
4	16.12	1.92	1244	3792.96
4	16.82	1.97	1346	4103.95
8	15.12	1.87	1662	5047.44
8	16.24	1.92	1728	5268.67
8	16.82	1.97	1815	5533.94

The results exhibited in this table show, that the windage causes a great diminution of the initial velocity, and that the greater the windage, the greater is the diminution. And the effective velocities should increase in proportion as the weight of the shot is lessened, because these velocities are in inverse proportion to the square root of the weight of the shot. Thus, in the 3d experiment, the velocity being 1346 feet, that of the first should have been 1424; yet it is actually only 1225 feet; consequently the difference of $\frac{1}{20}$ of the caliber in the windage, has produced a reduction in the velocity of 199 feet, or about $\frac{1}{6}$ of the effective velocity with a charge of 4 ounces; and the quantity of powder lost is nearly $\frac{2}{7}$. We find also that with a charge of 8 ounces, the velocity lost by a difference of $\frac{1}{20}$ of the caliber in the windage, is $\frac{2}{13}$ of the velocity found by the experiment, and the loss of powder $\frac{4}{15}$; a little less than with the small charge. Accordingly for every $\frac{1}{20}$ difference of windage, the diminution of velocity varies according to the charges in a decreasing ratio from the smallest to the largest. But this scale extends only, in all calibers, to the charge for the maximum of velocity, beyond which it retrogrades. Thus in piece

No. 1, the diminution of velocity ceases when the charge exceeds 12 ounces; whilst in No. 3 and 4, the diminution extends even to 16 ounces before it retrogrades. A knowledge of the mean ranges of cannon of established calibers, is of very great importance: we will here give the result of Hutton's experiments with the pieces No. 2 and 3.

Mean ranges of cannon, found by experiments.

TABLE

Of Mean Ranges, and the Time of Flight.

(In English Measures.)

Number of the piece	Charge	Ball. Weight	Ball. Diameter	Elevation of the piece	Time of flight	Range. in feet	Range. in mètres	Velocity by the pendulum in feet	Velocity by the pendulum in mètres.
		oz	Inches		Sec'ds				
2	2	16.625	1.9	45°	21.2	5109	1557.7	863	262.13
	2	16.313	1.959	15	9.2	4130	1259.2	868	264.65
	4	16.521	1.96	15	9.2	4660	1420.8	1234	376.25
	8	16.782	1.962	15	14.4	6066	1849.5	1644	501.26
	12	16.750	1.95	15	15.5	6700	2042.8	1676	511.01
3	8	15.469	1.96	15	10.1	5610	1710.5	1938	590.9

Doctor Hutton determined what charges in each of the pieces that he used, produced the greatest velocity, by observing the portions of the bore occupied by each charge.

TABLE

Of Charges producing the greatest velocities.

Number of the piece.	Length of the bore.	Length of the bore in calibers.	Maximum Charge.	
	Decimètres.		Ounces.	Kilogramme
1	7.163	14	12	0.34
2	9.677	19	14	0.397
3	13.57	28	16	0.453
4	20.295	$39\frac{1}{2}$	18	0.509

Experiments on the depth to which a shot will sink fired against elm wood.

Hutton also fired balls from piece No. 2, against masses of elm wood; and he found that with charges of 2, 4, and 8 ounces, the mean depth to which the shot sunk in the wood was 7, 15,

and 20 inches English: thus showing that the ratios of depth decrease. It is very probable that over a certain charge or velocity, the depth becomes stationary: the Cherbourg experiments never sunk the shot to a greater depth than 42 inches (45 inches Eng.). The fibres of the wood yielding with elasticity to the force of the shot, oppose to it a resistance increasing with the depth to which it sinks and with the increase of the initial velocity; and then collapsing, almost entirely close up the opening made in the wood by the shot.

Summary of the principal consequences to be deduced from Hutton's experiments.

From these admirable experiments follow many consequences deserving our attention.

1st. The ratio of the velocities appear to follow that of the square root of the weight of the charge, until the charge is about equal to one half the weight of the shot; this ratio diminishes in proportion as the increase of the charge causes it to occupy a greater portion of the total length of the bore.

This ratio of velocities would probably be the same with all charges, if the length of the bore were extended indefinitely towards that point where the elastic force of the inflamed powder, in consequence of dilatation and refrigeration, tends to an equality with the atmospheric pressure, and at which it is plain that the mobile has received from the charge all the degrees of successive velocity. Nevertheless it must be observed, that the ratio of velocity must vary according to the angle of inclination of the line of fire; for when this line is horizontal, the charge experiences from the shot only that degree of resistance which arises from its inertness and friction; but when the fire is under an angle of elevation, the shot opposes additional resistance from its weight and the angle of elevation, &c.

Doctor Hutton's experiments throw no light on this important point; and this should induce us to believe that the initial velocities in the latter Table of Ranges are not exact, for they were all fired under greater or less angles of elevation.

2d. The velocity of the mobile increases with the charge to a certain limit, beyond which it gradually diminishes with the increase of the charge until the bore is entirely filled with powder.

The charge for the greatest velocity, is different in each gun, increasing in each in proportion to the number of calibers in the length of the bore; but there is a great inequality between the ratio of these charges, and that of the lengths of the bore.

The portion of the bore occupied by the charge, is less in proportion to the total length in short pieces, than in long ones; for this portion is in reciprocal proportion to the part extending from the charge to the muzzle. This proves that it is not by the weight of the shot that we must attempt to determine the charges for the maximum of velocity; but by the ratios between the part occupied by the charge, and the total length of the bore.

D'Arcy fixed the extreme of the charge at from one half to one third the length of the bore: this agrees with the researches of Hutton with respect to pieces not exceeding 30 calibers; for the Doctor has shown that the longer the bore, the smaller is the ratio between the total length and the portion occupied by the charge. Thus for a length of 40 calibers, the length of the charge is between $\frac{1}{4}$ and $\frac{1}{3}$. Applying this principle to a 24 pounder of nearly 21 calibers length of bore, we find that the space occupied by the charge for the greatest velocity is about $\frac{3}{13}$ of the length of the bore, consequently 9 inches. The charge would therefore be 26 pounds of powder, a weight exceeding that of the shot. It is the same with all other battering and garrison pieces; the weight of the charge for the greatest velocity, exceeding that of the shot: but in field pieces, it about equals the weight of the ball.

Important fact relative to the effects of artillery.

The experiments, founded on the ranges, which would lead us to believe that the maximum of the charge is half the weight of the shot, are therefore erroneous. If for ordinary charges $\frac{1}{3}$ of the weight of the shot has been adopted, it is because this charge yields adequate ranges for all common occasions; but it is unquestionable that we only attain the greatest effect by a charge superior or at least equal to the weight of the shot. This fact is of the greatest importance in many circumstances*.

3d. The velocity unceasingly increases with the length of the bore; but the ratios of this increase do not follow those of

* A knowledge of this fact is of importance in battering breaches in masonry scarps, &c.; generally, however, the charge used in these cases does not exceed $\frac{1}{3}$ the weight of the shot, on account of heavier charges breaking the carriages, and endangering the gun, being more expensive, and requiring very slow firing. The charge for field service, especially in the American artillery, is $\frac{1}{4}$, and even sometimes $\frac{1}{5}$ of the weight of the shot. See the tables No. 1 and 2, in the volume of plates.

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the length: and indeed we find that the ratios of velocity are included between those of the square and cubic roots of the length of the bore: Robins and D'Arcy both found this to be the fact. The length of bore which gives the greatest velocity must necessarily be very considerable, since it should reach that point whereat the elastic fluid produced by the inflammation of the powder, is so much dilated as to be in equilibrium with the atmospheric pressure. But as this fluid is much more elastic than the air, the equilibrium cannot be established till after the shot has traversed a very great length of bore; accordingly D'Arcy found that a 24 pounder, loaded with 8 lbs. of powder, should have a bore 340 feet (364 feet) long to produce the maximum of velocity*.

Consequence of, and reflections on the length of the bore.

It follows from the preceding, that long guns are superior to short pieces, and that all the artillery of Europe, instead of having exceeded the length of bore that gives the greatest effect, fall much short of it. It is only the convenience of service, facility of manœuvre, and ease of transportation, &c. that caused the short pieces to be adopted.

4th. All other things being equal, the ranges increase in a much smaller ratio than the velocities, and it is inferior to the ratios of the square roots of these velocities. This induces us to assume for the ratio of the ranges, the ratio of the fifth root of the length of the bore.

Consequences, and considerations.

Hence it is evident that even a great increase in the length of the bore, produces but a very slight increase of range; in-

* The longer the bore, the more perfect should be the cannon, and the less the windage. May not the escape through the windage, and flight before the shot, of part of the elastic fluid, produce such shocks and eccentricities and opposition to the shot, that it will be found in practice at least, that this theory of long bores is far from being so certain. Besides, if there were no windage at all, which in practice is an impossibility, it deserves consideration whether the removal of a *column* of air of the diameter and almost of the length of the bore, with such velocity, would not towards the extremity of the bore be a great effort for the shot, and consequently reduce its initial velocity. The elastic fluid escaping in a stream through the superior windage, may produce a great increase of friction against the inferior side of the bore, and thus diminish the powers of range and velocity of long bores. Experiment is the only test of these occult laws of nature, which, like spirit, seem, in consequence of the imperfection of matter, to sometimes set the most rational conclusions at defiance.

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somuch, that in doubling the length of bore, we obtain only at farthest $\frac{1}{7}$ more of initial velocity. Therefore, with reference only to the ranges, there is very little to be gained by even greatly increasing the length of pieces. Hence it follows, that it is not by the ranges we must judge the total power of artillery.

5th. The experiments of Hutton, Lombard, and others, prove that neither the initial velocity, nor range, sustain any sensible diminution from any difference in the weight of the piece, from the use of wads, or from the more or less ramming of the charge; nor in fine by communicating the fire to the centre, rear, or front of the charge.

6th. The windage causes a great diminution of the velocity: accordingly in the French artillery great pains have been taken to reduce it to the smallest possible quantity; it is not $\frac{1}{13}$ in 24 and 16 pounders, and in field pieces it is only $\frac{1}{33}$.

Deviation of shot from the plane of projection, and the causes; their influence on the accuracy of fire.

7th. The experiments made by Hutton and others, prove that the shot often deviates from the plane of projection and describes a trajectory of double curvature: this deviation is often 8 degrees, and sometimes 15 degrees. What is most remarkable is, that the shot flies from one side to another, and that these deviations possess a kind of progressive regularity in their increase and decrease. The causes of these deviations are very complex, and as yet little known: they may be attributed to the shock and bouncing of the shot in the bore, to the various rotatory motions by which it is affected at leaving the gun, or in consequence of the resistance of the air, &c. It may be well to remark, however, that the causes of eccentricity do not act with great power till near the end of the trajectory, when the ball has lost great part of its velocity; and that, excepting the angle of departure, these causes do not sensibly diminish the correctness of the firing when the ranges are moderate.

On the means used to determine the initial velocities of projectiles.

The results that we have now investigated, though deduced from experiments made with the greatest care and directed by a man as able in theory as he was skilled in practice, are far from sufficing to establish a true practical ballistic theory. The means used by Hutton and the other learned men who preceded him, to determine the initial velocities, are subject in practice to a great many defects necessarily producing more or less important errors. The most striking defects in these means are:

1st, that they cannot be used in experiments made with the pieces in common use; 2d, that they relate only to horizontal firing; though it is very obvious that the initial velocities, all things else equal, must vary according as the angle of fire is nothing, or is above, or below the horizontal; 3d, that they require too complicated a knowledge of dynamics.

Mathey's instrument to find the initial velocity o projectiles; its defects.

It appears, according to Antoni, that a mechanician named Mathey was the first who conceived the idea of an instrument by which the initial velocity of projectiles may be deduced by merely remarking a known movement of rotation. It was composed of a paper cylinder turning on a vertical axis, and put in uniform motion by means of a weight. By firing horizontally in the vertical plane cutting its axis, the projectile pierced the cylindrical surface in two points; the position of the second, in relation to the diameter passing from the first, gives the arc described by the cylinder in the time that the mobile was passing through the distance between the two points. This instrument, the idea of which is very ingenious and mathematical, cannot be used, because it cannot be constructed of an adequate diameter, and it would in its movement make undulations that would render the results very uncertain: besides, it never can be of use in inclined firing.

Col. Grobert's instrument to measure the initial velocities of projectiles. (See the Memoirs of the author, in the Report made to the *Institute* on the 20 Frimaire 12 h year, by Messrs Bossut Monge, and Prony.)

Colonel Grobert, by adopting the simple and ingenious idea of making the rectilinear movement dependent on the movement of rotation, which is easy to establish and note, endeavoured to discover an instrument that had not the defects of Mathey's, and which could be easily constructed and applied generally to the artillery in use. The principle of his invention is to place on a horizontal axis of rotation 35 decimètres ($11\frac{3}{4}$ feet) long, two perpendicular disks, the whole moved by a weight attached to a cord putting a peritrochium in motion. This peritrochium has a wheel furnished with an endless chain passing through a pulley fixed on the axis of rotation. When the instrument has acquired its uniform movement, the cannon is established horizontally and parallel to the axis of rotation at a little distance from the first disk, and so that its direction will be distant about 10 decimètres (40 inches) from the line that cuts the centres of the disks. It is evident that the two holes made by the shot in the two disks, will not be in a line parallel to the axis: but if through each point or hole, and through the line of the centres of the disks, we draw a plane,

the two planes will make an angle that will measure the arc described by a point of the disks in the time that the shot was flying through the interval between the two holes; and as the rotatory movement of the disks is uniform, and found by observation, hence the time of a given arc is easily deduced.

From this plain description, it is obvious that Col. Grobert's instrument essentially differs from that of Mathey, from the inconveniences of which it is exempt: 1st, the interval of the disks and their diameter render very sensible the parts dependent upon observation: 2d, the rotatory movement becomes regular and uniform in a few moments: 3d, the instrument may be so fixed, that the fire may be under greater or lesser angles. This latter modification is executed by making the two disks independent, by two separate axes of rotation, but in the same vertical plane, so that one of the disks may be more or less elevated; this permits a certain inclining of the fire: 4th, this process, by means of a proper construction, may be applied to the pieces of artillery in use. We will not enter further into the details; but we recommend the students to read with attention the report made to the Institute by Messrs. Bossut, Monge, and Prony, to which are annexed the memoirs, descriptions, and drawings of the author.

49. The second phenomenon in mechanics on which the theory of gunnery is founded

49. Let us now suppose that the shot or projectile has left the mouth of the piece, taking its flight according to the direction of the axis, with a known or supposed initial velocity; and that the question is to examine the operation of the fire, abstracting for the moment from our consideration the causes of deviations arising from the imperfection of matter.

The two conditions necessary in firing a cannon.

In firing a piece two general conditions must be fulfilled:

1st. The axis of the bore must be accurately placed in the vertical plane of projection, in order that the trajectory described by the mobile be situated in this same plane.

2d. The axis of the piece must be so inclined towards the vertex or horizon, that the trajectory must necessarily pass through the object ("*but*") situated in the vertical plane of projection.

The first depends upon the construction of the cannon, and the method of manuœvring it: and is, according to the modes of practice, more or less simple.

The second depends upon the highest branches of mechanics,

and has been treated by Newton, Euler, Borda, Legendre, and others.

Mode of pointing the axis of a gun in the vertical plane of projection.

To be able to place the axis of a cannon in the vertical plane passing through the object and the battery, an imaginary line is drawn on the superior surface of the piece that the eye may readily seize, and situated in the same plane as the axis; this line must be so determined, that when it is placed in the vertical plane of projection, the axis must be also in it.

The natural sight line of mortars, stone mortars, howitzers, and guns.

This line traced upon the surface of a piece, and by which we find whether the axis is in the vertical plane of projection, is called the *natural line of sight*. In mortars and stone mortars this line is always placed between two metal points, one at the cascable and the other at the extreme of the chace, and both situated in the plane that passes through the axis of the piece, and perpendicular to that of the trunnions: hence it is, that in firing mortars and stone mortars the axis of the trunnions should be ever horizontal.

This natural sight line is a little variable in guns and howitzers, for in firing these pieces the axis of the trunnions is often more or less inclined. The experienced eye readily seizes the superior tangent that is in the same verticle plane as the axis, and which cutting at one point the cascable and at another the swelling of the muzzle, serves as a line of sight. If this line were determined by two fixed points, it is evident that by the least inclination of the trunnion axis from the horizontal, the line of sight and axis of the bore would no longer be in the vertical plane of projection. It is this reason in respect to the line of sight, that renders the firing of guns and howitzers so prompt and facile.

It is now easy to fulfil the first condition in firing: for mortars and stone mortars a platform is established perfectly horizontal, and on this the bed is placed; the axis of the trunnions being horizontal, and the object being visible, then by means of a plummet the line of sight and object are brought into the vertical plane of projection. When the mortar is covered by an epaulment that masks the object, two stakes are placed in the superior surface of the epaulment, and give the direction. In guns and howitzers, it is only necessary to seize the line of sight and direct it against the object.

Second condition or ballistic problem and its peculiarities.

The second condition is the ballistic problem, which, when applied to the fire of artillery, assumes a very peculiar expres-

sion. The indefinite prolongation of the axis of the bore, is called the *line of projection;* the point of departure of the mobile, is called the *battery;* the angle made by an horizontal line cutting the battery, and the line of projection, is called the *angle of projection;* the curve described by the mobile, is the *trajectory;* that part of the horizontal line which is contained in the trajectory, is its *amplitude;* and finally, the greatest vertical ordinate, is called the *height of the flight.*

The phenomena, occurring in vacuum.

If we were to suppose that the phenomena of motion took place in a *non*-resisting medium, then their circumstances could be easily determined by the simplest doctrines of mechanics. In this case we know that the body is subjected to the action of two forces, both situated in the vertical plane of projection, and consequently the trajectory would be a plane trajectory and situated in this same plane. The first of these forces is that to which the body owes its initial velocity; being an impelling force in the direction of the axis of the bore, and in consequence of which the motion would be uniform if it acted alone. The second is gravity, acting vertically, and like a constantly accelerating force continually forcing the body below the line of projection; and which would, if it acted singly, attract it by an uniformly accelerated motion. These two forces acting together upon the mobile, would force it to move in a plane trajection, tangential to the point of departure in the line of projection and contained in the vertical plane cutting this line. If h be the height produced by the velocity V; a the angle of projection; x and z the co-ordinates; the general equation of the trajectory will be, $z = x\ tang.\ a - \frac{x^2}{4h\ cos.^2\ a}$ (1).

Consequences and results, deduced from the equations of projectile bodies moving through vacuum. (See *Francœur's* Treatise on Mechanics; and the Memoir on the Ballistic by *Moreau*, of the Maritime Engineers, in the 11th No. of the Journal of the Polytechnick School.)

likewise we find the equation, $z = VT\ sin.\ a - \frac{1}{2}gT^2$ (2).

The system of these two equations illustrates all the circumstances of the motion: the equation (1) is that of a parabola, the construction of which is very easy, for the parameter is $4h.\ cos.^2\ a$; and its axis is vertical: the equation (2) shews the time of flight of the projectile.

The principal consequences are; 1st, the amplitudes with the same initial velocity are proportional to the sines of double the angle of projection, and the heights of flight are as the squares of the sines of the same angle: therefore the value of

the amplitude $= 2h\ sin.\ 2a$, and the value of the height of flight $= h\ sin.^2\ a$.

2d. The angle of projection that gives the greatest amplitude for a given initial velocity, is the angle of 50° or half a right angle*; for the expression $2h\ sin.\ 2a$ becomes the maximum when $a = \frac{1}{2}$ right angle.

3d. For a given amplitude depending upon an also given initial volocity, there are two angles of projection which produce this amplitude, unless it be a maximum; and the two lines of projection make an equal angle with the line forming half a right angle with the axis of the x's; this is easily shown by the value of the amplitude; for let A be this amplitude, and we find $A = 2h\ sin.\ 2a$ and $sin.\ 2a = \frac{A}{2h}$ or $a = \frac{1}{2}$ arc $\left(sin. = \frac{A}{2h}\right)$: this demonstrates that the amplitude cannot be greater than $2h$; and that when it is equal to this quantity, it is the maximum, and the angle of projection is then $\frac{1}{2}$ a right angle; and finally, that when A is less than $2h$, there are two angles of projection, and the difference of these two angles is divided into two equal parts by the line that forms the angle of 50° with the horizon and vertex.

4th. The whole time of flight is easily determined; the equation (2) gives, when $z = 0$, $0 = T\ (V\ sin.\ a - \frac{1}{2}\ gT)$ and $T = \frac{2\ V\ sin.\ a}{g} = 2\ sin.\ a \sqrt{\frac{2h}{g}}$: the velocity v in one point of the trajectory for which we have $x = b$, will be $v = \sqrt{2\ gh - 2\ gb\ tang.\ a + \frac{gb^2}{2h\ cos.^2\ a}}$; and the time t, at the end of which the projectile is in the same point for which $x = b$ will be expressed by $t = \frac{b}{V\ cos.\ a} = \frac{b}{cos.\ a \sqrt{2\ gh}}$.

Such are the known relations of the circumstances of motion, and of which the theory of gunnery might make the most immediate application, if the hypothesis of vacuum could be admitted. But these mathematical principles can only be used as a term of comparison to which may be referred the approximating results obtained by the analysis, aided by experiment,

* The new division of the circle into 400 degrees, is here and hereafter alluded to. TRANSLATOR.

in investigating the phenomenon and the physical circumstances accompanying it.

The phenomenon when passing through air, a resisting medium (See the learned Treatises of Borda, and the works above cited)

The plainer the question when the projectile is supposed to be impelled through vacuum, the more complicated it becomes when the flight is through a resisting medium like the atmosphere. In this last case it becomes necessary to introduce into the mechanical analysis of the question, a third power directly opposed to motion, to represent the resistance of the medium at each moment to the mobile, and the direction of which in every point of the trajectory is that of a tangent to this point. This resistance of the air to the motion of bodies, is evidently a certain consequence of velocity; but its laws are not yet well understood, and there remains to be made on this subject experiments that require an able director. From what we already know, it is certain that when the velocity of projectiles is inconsiderable and does not exceed 100 mètres (112 yards) a second, the trajectory through the air does not very sensibly differ from that through vacuum; so that for all degrees of velocity not exceeding 200 mètres (225 yards), we may suppose the resistance is proportioned to the velocity: but this is not the case with cannon, whose velocity is never less than 300 mètres (335 yards,) and often exceeds 1500 mètres (1670 yards.) In the hypothesis adapted to the most common cases of artillery firing, where the velocity is from 200 to 600 mètres (290 to 670 yards), the resistance is admitted to be proportional to the square of the velocity, and Newton found its value expressed by $\frac{3}{8}\frac{D}{D'a}v^2$; a being the diameter of the projectile, D the density of the medium, D' the density of the mobile, and v designating the velocity: but the quantity $\frac{3}{8}$ is too little when the velocities become very great, and it is then proper to substitute for it 0.45. To understand how the motion of a shot impressed with great velocity, becomes very much changed, we must first know that air precipitates itself into vacuum at the surface of the earth with a velocity of 430 mètres (1437 feet or 479 yards). Consequently when the velocity of the projectile exceeds this quantity, the mobile creates behind itself a vacuum and is exposed in front to a greater pressure than in rear; this produces a most striking alteration in the circumstances of its motion, and which analysis has enabled us to discover.

Results and consequences deduced from equations of the motion of projectiles through a resisting medium.

We will now investigate the circumstances of the motion of a mobile fired through the air from a cannon, and will suppose that the resistance is proportional to the square of the velocity, in order, as in the preceding case, to obtain general results on which to establish a theory of gunnery. The more the question in cases of vacuum is simple, the more complicated it is by the introduction of a force representing the resistance at each instant of motion.

To express the relations of the circumstances of the motion of a mobile impelled through the air by artillery, we must in this particular case apply the general equations of the motion of a body in a curved line; using and designating properly the different species of quantities to be considered.

a = the angle of projection; this is the angle made by the line of projection with the axis of the x's.

h = the height produced by the initial velocity V.

v = the velocity of the body in the line of the trajectory at the end of any given time.

$\frac{1}{2} A v^2 =$ { the resistance of the air, supposed to be proportional to the square of the velocity. A = a constant quantity, determined by experiment.

$K =$ { the height from which the mobile must fall to experience a resistance from the air equal to its weight.

e = the number represented by the Naperian logarithm 1.

S = the arc described by the mobile in its trajectory at the end of any given time t. $\frac{dy}{dx} = p$.

These being established, the general equations of motion applied to the case under consideration, give:

$$-e^{AS} = 2h \cos.^2 a \frac{dp}{dx}. \text{ (See Francœur's Mechanics, p. 198.) } (E)$$

and.... $dS = \sqrt{dx^2 + dy^2} = dx\sqrt{1 + p^2}$: by multiplying these two equations we obtain,

$$-e^{AS} dS = 2h \cos.^2 a \, dp \sqrt{1 + p^2} \quad (1)$$ which being integrated, gives

$$-e^{AS} = Ah \cos.^2 a \left\{ p\sqrt{1 + p^2} + \log.\left(p + \sqrt{1 + p^2}\right) + C \right\}$$

which becomes by resolving C: $+ e^{AS} = 1 + Ah \cos.^2 a \times$

$$\left\{ \frac{\sin. a}{\cos.^2 a} + \log. tang.(50° + \tfrac{1}{2}a) - p\sqrt{1+p^2} - \log.\left(p + \sqrt{1+p^2}\right) \right\}$$

it we then take the logarithms, and to shorten the operation make $\frac{sin.\ a}{cos.^2\ a} + log.\ tang.\ (50° + \frac{1}{2}\ a) = f$; we shall find

$$S = \frac{1}{A} log. \left\{ 1 + Ah\ cos.^2 a \left(f - p\sqrt{1+p^2} - log.(p + \sqrt{1+p^2}) \right) \right\} (2).$$

to bring into this equation the quantity K, that is supposed to be found by experiment, we must find a proportion between it and the co-efficient A. For this we have the formula $\frac{1}{2}\ A\ v^2$ representing the resistance of the air relative to the velocity v: but as we suppose that the body falls from the height K, we find $v^2 = 2g\ K$. The resistance of the air therefore at the end of the fall will be $A.MgK$, calling M the mass of the body: but as the quantity K is supposed such, that the resistance is equal to the weight, we find $A.MgK = Mg$, or $AK = 1$; which gives $A = \frac{1}{K}$. The equation (2) will then become

$$S = K\ log. \left\{ 1 + \frac{h\ cos.^2 a}{K} \left(f - p\sqrt{1+p^2} - log.(p + \sqrt{1+p^2}) \right) \right\} (3).$$

Relation between the trajectory through air, and that through vacuum.

If in the equation (1) we suppose $A = 0$, which amounts to supposing that the body moves in vacuum, we will find by changing S into S' and integrating,

$$S' = h\ cos.^2\ a \left(f - p\sqrt{1+p^2} - log.(p + \sqrt{1+p^2}) \right) (4).$$

This latter reduces the equation (3) to:

$S = K\ log. \left(1 + \frac{S'}{K}\right)$ (5). An equation establishing the proportion between the corresponding arcs S and S'.

Observations on, and deductions from the relations of the two trajectories.

It must be observed: 1st, that as the value of p should be the same for the arcs S and S', the tangents protracted to their extremes are parallel. So that if the arc S' be given, and the tangent be protracted to its extremity, the point terminating the corresponding arc S, will be that of the trajectory where the tangent will be parallel to the first.

2. The corresponding arcs S' and S increase simultaneously; but the arc S increases less rapidly: in the parabolic trajectory the direction of the tangent protracted to the extreme of the arc S' continually approaches the vertical, and only becomes perpendicular at the axis of the x's when $S' = \infty$: the same is the case in

The descending branch of the trajectory in air has a vertical asymptote, the position of which on the axis of the x's may be found.

the trajectory through air, when $S=\infty$, the tangent is perpendicular to the x's, but it is remarkable that this tangent is an asymptote; that is, it meets the axis of the x's at a finite distance. To demonstrate this, we will transfer the radical of the co-ordinates to the point of the descending branch where the tangent makes with the axis of the x's such an angle that we may without any sensible error neglect the square of the radius 1 against the square p^2 of its tangent.

Let a' = the angle made with the axis of the x's by the tangent at the new radical.

.. S'' = the arc of the trajectory calculated from the departure from this radical.

.. h' = the height produced by the velocity of the body at the same radical. $Tang.\ a'=p$.

These being established, the equation (1) becomes by omitting 1 against p^2 supposed very great;

$-e^{AS''}\,dS'' = 2h'\,cos.^2\,a'\,pdp$, which being integrated gives,

$-e^{AS''} = Ah'\,cos.^2\,a'\,(p^2+C)$; and as at the radical $S''=0$, and $p=tang.\,a'$, it follows that $C=\dfrac{1}{Ah'\,\cos.^2\,a'} - tang.\ a'$, and that the preceding equation becomes

$-e^{AS''} = 1+Ah'\,cos.^2a'\,(p^2-tang.^2a')$: if now we substitute for A, its value $\dfrac{1}{K}$, and for $-e^{AS''}$ its value $\dfrac{dp}{dx}\times 2h'\ cos.^2\,a'$ deduced from the first equation (E), by substituting S'' in the place of S, h' instead of h, and a' in the place of a, we will have $\dfrac{dx}{2K}=\dfrac{dp}{p^2+\dfrac{K-h'\,sin.^2\,a'}{cos.^2\,a'}}$; and as the quantity $\dfrac{K-h'\,sin.^2\,a'}{cos.^2\,a'}$ is always positive, it may be represented by m^2, and we will have $\dfrac{dx}{2K}=\dfrac{dp}{p^2+m^2}$; integrating and determining the constant, by observing that at the new radical we find at the same time $x=0$, and $p=tang.\ a'$, it becomes

$x=\dfrac{2K}{m}\left\{\text{arc}\left(tang.=\dfrac{p}{m}\right)-\text{arc}\left(tang.=\dfrac{tang.\ a'}{m}\right)\right\}$: if now we suppose that in the equation p becomes infinite; that is, if we consider that point situated in the infinite where the vertical tangent touches the descending branch, we will find for

the value of the corresponding abscissa, by calling G the amplitude, $x' = G + \frac{2K}{m}\left\{\frac{\pi}{2} - \text{arc}\left(tang. = \frac{tang.\ a'}{m}\right)\right\}$; which demonstrates that the value of x', compared to the radical of the curve, is finite, and known when K and a' are known.

The ascending branch of the trajectory has an inclined asymptote, the position of which may be found on the axis of the x's.

If now we consider the ascending branch, and assume the arcs S and S' beneath the radical, we must take them negatively, and the equation (5) will become $-S = K\,log.\,(1 - \frac{S'}{K})$; the hypothesis of $S' = K$ makes S indefinite; which shows, that if we assume on the parabola beneath the radical an arc numerically equal to the quantity K, and protract to its extremity a tangent, this line will be parallel to that which would be protracted to the point in the ascending branch situated at the infinite: thus the ascending branch has an asymptote inclined to the axis of the x's, and the position of which may be calculated; that is, the point where it meets the axis of the x's and the angle which it makes with this axis. To do this, we must resume the equation,

$$e^{\frac{S}{K}} = 1 + \frac{h\,cos.^2\,a}{K}\left(f - p\sqrt{1+p^2} - log.(p + \sqrt{1+p^2})\right);$$

if in this equation we substitute for $e^{\frac{S}{K}}$ its value deduced from the equation $-e^{\frac{S}{K}} = 2h\,cos.^2\,a\,\frac{dp}{dx}$, and we multiply the two members by $2K$, we will have

$$\frac{2kdp}{dx} = -\left\{\frac{K}{h\,cos.^2 a} + f - p\sqrt{1+p^2} - log.\,(p + \sqrt{1+p^2})\right\}.$$

To throw this equation into a more concise form, make

$$\frac{K}{h\,cos.^2 a} + f = n, \text{ and } p\sqrt{1+p^2} + log.\,(p + \sqrt{1+p^2}) = P,$$

and we will find by taking the value of dx, $dx = -\frac{2K\,dp}{n - P}$, and $dy = -\frac{2K\,pdp}{n - P}$, because $dy = pdx$. Substituting these values in the equation (3), gives, $S = K\,log.\left(\frac{h}{K}\,cos.^3\,a\,(n - P)\right)$: as p is the trigonometric tangent of the angle that the tangent

protracted to the extremity of the arc S, makes with the axis of the x's, if this tangent be an asymptote, it must be that $S = \infty$; and this condition will be fulfilled by the equation $n = P$: by this relation between n and P we determine the tangent of the angle of the asymptote with the axis of the x's. To find the abscissa corresponding to the asymptote, we will take the formula $x - \frac{ydx}{dy}$ which represents this abscissa ; and substitute therein for x, y, dx, dy, the values found above ; we will then have for the value of the abscissa sought,

$x' = \frac{2K}{p}\int \frac{pdp}{n-P} - 2K\int \frac{dp}{n-P}$, taking care to take the integrals from $p =$ tang. a, to the value of p, which extinguishes $n - P$.

Construction or delineation of the trajectory when the angle of projection is very small, and the curve little elevated.

To arrive at the description of the curve, we would remark that it can only be traced in general by points, and can only be deduced from the relation between x and y when a is very small : the question therefore is to find a relation between x and y. For this purpose let us resume the equation

$$S = K\,log.\left\{1+\frac{h\,cos.^3 a}{K}\left(f - p\sqrt{1+p^2} - log.\left(p+\sqrt{1+p^2}\right)\right)\right\}.$$

By passing to the numbers, we have

$$e^{\frac{S}{K}} = 1 + h\frac{cos.^2\,a}{K}\left(f - p\sqrt{1+p^2} - log.\left(p+\sqrt{1+p^2}\right)\right);$$

but we find by the equation (E), by substituting for A its value $\frac{1}{K}e^{\frac{S}{K}} = -2\,h\,cos.^2\,a\,\frac{dp}{dx}$; by substituting this value in the preceding equation, we have

$$\frac{dp}{dx} = -\frac{1}{2\,h\,cos.^2\,a} + \frac{1}{2K}\left(p\sqrt{1+p^2} + log.\left(p+\sqrt{1+p^2}\right) - f\right)$$

to integrate this equation, make $p = C + A'x + B'x^2 +$ &c. ; and we will have the first term, $C = tang.\ a$; then take in this equation the value of $\frac{dp}{dx}$ which will be substituted in the preceding, and we determine the unknown co-efficients A', B', &c. : this makes $p = tang.\ a - \frac{x}{2h\,cos.^2\,a} - \frac{x^2}{4hK\,cos.^3\,a}$ — &c. : re-

placing p by its value $\frac{dy}{dx}$, and integrating again, we find

$$y = x\,tang.\,a - \frac{x^2}{4}.\frac{1}{h\,cos.^2 a} - \frac{x^3}{3.4}.\frac{1}{hK\,cos.^3 a} - \frac{x^4}{2.3.4.} \times \left(\frac{1}{2hK^2\,cos.^4 a} - \frac{1}{4h^2K\,cos.^4 a}\right) + \&c.$$

This series is very convergent when a is very small; consequently we may use it with advantage in the special cases of ricochet firing, and of cannon firing on plains when a is very little: in such cases it will be sufficient to take the three first terms of the series.

Tracing the trajectory by points, when the angle of projection is more or less considerable. (See PLATE VI, fig. 7.)

To construct the trajectory when a is any quantity whatever, we cannot deduce the graphical figure from the relation between x and y; it must therefore be traced by successively determined points, by gradually and slightly varying the inclination of the elements of the curve. To trace the ascending branch AMD, conceive it to be divided into the parts ab, bc, co, &c. sufficiently small to be considered straight lines: suppose also that the angles formed by these small rectilinear elements with the horizon, diminish successively one degree, so that the first angle $b\,A\,P$, being known, the others are also known. These being granted, then if in the equation (3)

$$S = K\,log.\left\{1 + \frac{h\,cos.^2 a}{K}\left(f - p\sqrt{1+p^2} - log.\,(p\sqrt{1+p^2})\right)\right\}$$

we put for p the value agreeing with cbe, we will find the length of the part bc; we will find likewise the two sides be and ce of the rectangled triangle bce: in the same way are calculated co, and of, and of, &c. The same operation will be continued until the angle of inclination becomes equal to *zero*, when we will have found the summit D of the trajectory; and by adding together all the several arcs, we have the ascending branch AMD; and by uniting the horizontal bases of the small triangles, we find its amplitude AP. Finally, by uniting all the vertical heights of these same triangles, we find the height of the flight DP. By departing from the point of the ascending branch where $p = o$, we find successively the negative values of p beginning with one degree, and increasing one degree at each new operation, and we will obtain by the formula the corresponding values of the elements of the descending branch; and consequently the extent or display of this branch, and its amplitude, which being add-

ed to that already found for the ascending, will give the total amplitude. The calculation may be abridged by the consideration that for values equals of p, but of contrary signs, the values of S are likewise of the same magnitude ; but they are attached to different signs : as $p\sqrt{1+p^2}$ changes into $-p\sqrt{1+p^2}$ when p is negative ; in the same way $log.\left(p+\sqrt{1+p^2}\right)$ changes into $-log.\left(p+\sqrt{1+p^2}\right)$.

The velocity at a point of the trajectory, and the time in which it is passed thro'. (See the Essay on the Ballistic, referred to precedingly.)

In proportion as we determine the elementary arcs of the trajectory, we can also determine the velocity at the extreme of each arc ; and consequently the velocity at the different points of the curve. In the same manner may be calculated the time in which each element is traversed, and these spaces of elementary time being added together give the whole time in which the ascending and descending branches were respectively traversed. In fine, the analysis unfolds the degree of curvature of the trajectory at its different points.

General results of the analysis.

It follows from all these analytic considerations, that the circumstances of the motion of projectiles fired through the atmosphere from cannon, are known in an approximating manner, and that they should guide us in establishing a theory of gunnery. By recapitulating the general consequences deduced from the analysis, we find, 1st, that the trajectories can only be traced by successive points when the angle of projection is not very small ; but that in this latter case, we can deduce the figure from the relation between the co-ordinates.

2d. That the ascending and descending branches are unlike. and are contained between two asymptotes, the position of which is known on the axis of x ; that the ascending branch is least remote from the parabola ; that its curvature is less than that of the descending branch ; and that the velocity of motion is greater in the former than in this latter.

3d. That the greatest curvature is not at the summit, but at the point L a little beyond it ; neither is the least velocity at the summit, but at the point G, which is further from the summit than L. (PLATE VI, fig. 7.)

4th. When the mobile has passed through the point G of the minimum of velocity, the motion accelerates indefinitely, but very slowly, and without the velocity ever possibly transcending a given limit determined by the calculation.

5th. The amplitude of the ascending branch is greater than

that of the descending; and the total amplitude is much less than what it would be in vacuum. When the initial velocities are very great, there is between the two amplitudes such differences, that the amplitude in air is only $\frac{1}{6}$ or even $\frac{1}{10}$ of the amplitude in vacuum.

Manner of determining the quantity K in the formulas which express the circumstances of motion of the various species of projectiles fired from cannon through air.

The quantity K that enters into the formules which explain the circumstances of the motion of projectiles through air, is, as we have seen, the height from which the projectile must fall to sustain from the air a resistance equal to its weight: this quantity should be calculated for each kind of projectile, and for the two cases of mean and very great velocities.

We will distinguish mobiles into two classes; the first comprehending bombs and howitzes, and the second including balls of all calibers. In the same manner we will distinguish velocities into two kinds; 1st, that of bombs, howitzes, and balls fired in *ricochet;* 2d, that of cannon of all calibers, with the greatest charges and at random.

We have seen above that if D' and D represent the respective densities of the globe, and of the air, and if a be its diameter, we find the resistance $R = \frac{1}{2} A v^2 = \frac{3}{8} \cdot \frac{D v^2}{D' a}$ for cases of mean velocities; and $\frac{1}{2} A v^2 = 0.45 \cdot \frac{D v^2}{D' a}$ for very great velocities; and as $A = \frac{1}{K}$, it follows that

$$K = \begin{cases} \frac{4}{3} \cdot \frac{D' a}{D} & \text{for mean velocities.} \\ 1.111 \cdot \frac{D' a}{D} & \text{for great velocities.} \end{cases}$$

Remarks on bombs and howitzes.

It must be observed that for bombs and howitzes the density D' is a mean density, obtained by multiplying the density of the metal by the ratio $\frac{P}{P'}$, P being the weight of the hollow mobile, and P' that of the same mobile considered as homogeneous. Thus for example, for a 24 pound ball impressed with a great velocity produced by a charge of 12 pounds, we have $a = 0^{mt}, 15$; $D' = 6047$ $D = 1$, and $K = 0^{mt}, 15 \times 6047 \times 1.111$. If the ball be fired with a charge giving it a mean velocity of about 460 mètres, we would have $K = 0,^{mt}\ 15 \times 6047 \times \frac{4}{3}$: finally, if the ball be hollow and weigh about 6 pounds, we should have $K = 0,^{mt}\ 15 \times 6047 \times \frac{6}{24} \times \frac{3}{4}$.

When the phenomenon takes place in vacuum, the angle that always gives the maximum of amplitude is that of 50°, (n m); but this is not the case when the movement takes place through air; this angle is then always less than half a right angle, and varies according as the mobiles are impelled with a greater or less initial velocity, and according to the laws of resistance: we find this angle by first finding the limits within which it is included, and then using the method of interpolations.

Angle of projection affording the maximum of amplitude.

To perfectly convince ourselves of these truths, and become familiar with the operations of the calculations that lead to the graphical construction of a trajectory, the students will calculate the circumstances of the motion of a 24 pound shot fired through air from a gun under a given angle of projection, and with a given initial velocity; and they will compare the results of this hypothesis, with that of the hypothesis of the movement being through vacuum. We give here the results, for the benefit of our young readers who are averse to these long and laborious calculations.

Application of the preceding principles to the movement thro' air of a 24 pound shot.

The data in this case, are;

Data in this case.

The angle of projection	45° (old m).
The initial velocity	486. mt 27. (541 yards).
The projectile or 24 pound shot	117. hect 39. (26lbs. av's. Eng.)
The diameter of the shot (a)....	0. mt 15. (5 in.)
The density of the air	1.
The density of cast iron	6047.
The quantity found for K	1209. mt (1334 yards).

The dimensions of the trajectory and the circumstances of the motion being calculated according to these data, we find the result to be as follows:

Movement through vacuum.	Amplitude	23755. mt 60	(about 26,400 yds.)
	Height of flight	5941. 40	(.. 6,603 yds.)
	Time of flight	97." 7	
Motion through the air.	Amplitude of the branch, ascending. 2427 mt 796 + descending 1370. 300	3798. mt 096	(about 4220 yards.)
	Height of flight	1668. 866	(.. 1854)
	Duration of the movement in the branch, ascending. 14." 94 + descending. 21." 03	35." 97	
	Length of the trajectory	5303. mt 819	(about 5894)
	Maximum of amplitude	3855. 493	(.. 4284)
	Angle of the maximum of amplitude	31.° 99	(old m.)

These results show that the amplitude of the trajectory through air, is only about $\frac{1}{6}$ of what it would be in vacuum; and that the height of flight is not $\frac{1}{3}$ of what it would be in vacuum. Also, that the time of flight through air, is not one-half what it would be in vacuum; and that the angle which gives the greatest range, is far from being half a right angle.

Remark on the angle of the greatest range.

If the initial velocity decreased greatly, the angle of projection affording the greatest range would be nearly 45° (o m); by calculating it for a velocity of about 240 mètres (270 yards), we find it to be 37° .28, and for a velocity of 153 ^{mt} (170 yards), it reaches 42° .23; for a bomb of 0 ^{mt}, 32 ($12\frac{4}{5}$ inches) in diameter with a velocity of 114 ^{mt} (127 yards), the angle of the greatest amplitude is very nearly 45°, being in reality 43°.52.

Experience has established that for a 24 pounder, loaded with $\frac{1}{3}$ the weight of the shot, the angle of projection for the greatest range is about 42°; and for a bomb, filled with earth, it is about 43°.

The velocity of musket balls being very considerable, about 500 mètres (556 yards), it follows that the angle which gives the greatest range of a musket, is far from 45°; this fact is confirmed by experience.

Theory of gunnery applied to practice.

To apply the ballistic theory to practice, we must calculate the dimensions of the trajectories of the different kinds of projectiles, and form tables that will exhibit to the practical artillerist the circumstances of the movement in each particular case. But to construct these tables and trace the trajectories, it is requisite that experiments first establish approximatively the initial velocities impressed on mobiles; 1st, by the smallest charges; 2d, by medium charges in daily use; 3d, by the greatest charges that can be used. These experimental data being established, we next consider the manœuvres in the firing of each kind of artillery pieces; and in this respect the firing of mortars and howitzers of great ranges, is distinguished from cannon and common howitzer firing. In the first, the angle of projection is always above the horizon, and varies from 20° to 45°. In the second, the angle of projection may be below or above the horizon, varying from 0° to 20° above, and from 0° to 10° below the horizon. In the first case we may suppose the angle of projection to vary from 5° by 5°, in passing from one extreme to another; this will give for each kind of projectile 3 series of 5 trajectories, each relative to the

three charges mentioned. Therefore by tracing these trajectories, and calculating all the circumstances of the motion of the projectiles in each curve, we can construct tables that will be very useful as guides in practice: but it is necessary to calculate for each trajectory the chords successively protracted from the radical, and which rise above the amplitude by angles continually increasing 5 degrees. In the second case, where the fire takes place under angles never exceeding 20° above, nor 10° below the horizon, we must only vary the angles between 0° and the superior and inferior limits, by $2\frac{1}{2}$°; this will give for each species of projectile 3 series, including each 13 trajectories. In each series, one of these trajectories will relate to the case wherein the line of projection is horizontal; 8 will relate to the cases of the line of projection being above the horizon; and 4 to the line of fire below the horizon. In the kind of firing that we have just investigated, we must calculate the circumstances of the motion of the projectile in each trajectory; likewise the chords, the distance of the point blank, &c. All these species of quantities must form separate columns in the tables, so that at the first glance we can attain the solution of each particular case.

Solution of the two general questions in gunnery

When theory, aided by experiment, shall have constructed these tables, it will then be easy to resolve the two questions to which gunnery gives rise.

1st. A projectile being fired with a given initial velocity and in a known direction, it is required what trajectory it describes? Knowing the initial velocity, we can find the charge belonging to it, and this will designate the series containing the trajectory required; from the trajectories of this series we will then take that whose axis of projection makes with the horizon the angle given.

2d. The position of the object and the initial velocity being known, it is required under what angle the projectile must be fired? The projectile and initial velocity being known, we find the series including the trajectory, one of the points of which will have the same co-ordinates as the object: this trajectory being found, the angle of projection is also found, &c.

50. Firing of guns in practice.

50. We have observed that there are two kinds of firing to be distinguished; that with elevated trajectories, and that with depressed trajectories. The first relates to the firing of bombs and howitzes to great distances; the second, to cannon and

Method of firing howitzers and mortars.

common howitzers. Most commonly howitzers are fired like cannon; their figure and mode of service allowing this simpler and more expeditious method, which renders the use of this arm fit for all kinds of combats, and of great advantage under any circumstances. Howitzers are much used in the attack and defence of places. In sieges, bombs are also fired under small angles to produce ricochets: in this point of view, this is one of the most terrible weapons, as we will show more fully in the third part.

The practice in firing bombs and howitzes when the trajectories are high.

In firing bombs and howitzes with high trajectories, the position of the object being known, we begin by placing the axis of the bore in the vertical plane of projection (47); and calculate the initial velocity by the quantity of powder in the charge. With these two data the tables will show the angle under which the piece ought to be pointed; and we obtain this angle by observing that the plane of the muzzle is perpendicular to the axis, and by laying against it vertically the long arm of the quadrant, the pendulum will point on the limb the arc that measures the angle of projection.

Practice in the firing of cannon and howitzers when the trajectories are depressed.

Cannon and howitzers being used in all the operations of war, they should necessarily be manœuvred with promptness and rapidity; their fire should therefore be methodically practical, and simple, and by which the two conditions are by a single operation at once fulfilled. It must be observed, that these pieces being pointed under small angles above or below the horizon, it is not perhaps by calculating these angles that we can regulate ourselves in the execution of the fire.

Pointing by the natural sight line; the angle of sight; points of the trajectory called *points blank*.

The natural sight line is used to point cannon and howitzers at the object, and the angle is varied in proportion to the position of the object in relation to the battery. In both kinds of pieces, the natural sight line is in a certain degree inclined towards the axis; their profiles show the respective positions of these lines. In all cannon the sight line cuts that of the axis in front of and at a little distance from the muzzle; which distance is known: but in howitzers, these lines are parallel or even diverging. It follows from these general forms, that in all kinds of cannon the line of sight makes with the axis a constant and determinate angle, and this is called the *angle of sight* ("*L'angle de mire*"): but in howitzers there is no angle of sight.

(PLATE VI, fig. 8.)

Let us now suppose that the line of sight is horizontal, and

that we have drawn the trajectory belonging to the initial velocity of the charge in use, and likewise the line of projection; we will then find that the sight line after cutting the prolonged axis, cuts the trajectory very near this latter point, then passing under, cuts it a second time at a distance from the mouth a little less than the amplitude. It is these two points of intersection of the line of sight with the trajectory, that are called the points blank ("*Les points du but en blanc*"). The first, which is near the muzzle, it is useless to attend to; but the second, called the *primitive point blank*, regulates every part of the firing when the trajectories are depressed.

The original point blank.

As guns and field howitzers are always fired under angles never exceeding 20 degrees above the horizon, it is remarked, and the analysis confirms it, that the distance from the point blank to the battery is nearly constant: and we may consider the line that determines the original point blank as revolving about the point of the battery from the horizontal to the highest limit of 15 to 20 degrees. We should arrive at the same result by tracing the line of sight on the plane of the trajectories drawn in the tables of gunnery.

The slight difference between the original point blank, and the point blank of small angles above the horizon.

When the firing is beneath the horizontal, circumstances change; the trajectory has then only a descending branch, and the weight acting differently from the first case, the distance from the point blank to the battery differs from that of the original point blank; and even this distance varies sensibly for each inclination. It is therefore necessary to know the distance from the point blank to the battery for all the angles of projection included between 0, and 10 degrees below the horizon. In howitzers, where the line of sight is about parallel to the axis, there is no point blank; they are accordingly not fired with so much facility as cannon.

The point blank when the line of projection is at or below the horizon.

The firing of cannon and howitzers might be executed by means of angles of projection; but in most of the operations of war this method would be almost impracticable from its nicety and minuteness. The best and nearest mode, and that which only can be practised, and which requires no instrument, is by the visual ray passing along the sight line; and correcting the pointing by a few trials: this mode suits the rapidity of manœuvres, and is founded upon the consideration of the sight line and point blank.

Method of firing cannon and howitzers by the use of the line of sight and point blank.

For example, let us suppose; 1st, that the object is remotely (PLATE VI, fig. 8.)

placed at the point blank (A), it is then obvious that by directing the sight line against the object, the trajectory will pass through this point and the mobile will strike it. Accordingly in this situation of the object relatively to the battery, *we must take aim at the object by the natural sight line.* The same rule would exist if the object were placed in the point (A'), the nearest point blank. 2d. Place the object beyond the point blank, for instance in (A''); in this position that part of the descending branch of the trajectory corresponding to the object, would be below it, and the mobile would pass under the object or be stopped by the ground at (A); therefore the line or piece must be elevated by raising it above the point (B), in order that the point (D) of the trajectory may reach (A''); or what is the same thing, *we must take aim by a quantity given in the tables as much above the object, as the vertical* ($A''D$). Finally, if we suppose the object between the battery and the point blank, at (A'''), the mobile will pass as far above it by a quantity equal to the vertical ($A'''D'$); consequently in this case the piece must be depressed below the point (B), in order that the point (D') of the trajectory cut the point (A'''); or what is the same, *we must take aim below the object by a quantity given by the tables, and about equal to the vertical* ($D'A'''$). Such are the general precepts of theory to serve as rules in the pointing of cannon and howitzers.

First rule.

Second rule.

Third rule.

On howitzers.

As the line of sight in howitzers is almost parallel to the axis, these pieces have no point blank; in all cases therefore we must sight them above the object in order that the shot strike.

The artificial sight line, to obtain in all cases the point blank.

We find from the profiles of cannon and howitzers that the natural sight line is insufficient in all cases to fire point blank. We call *firing point blank, when aim is taken at the object by the sight line, and the trajectory cuts that object.* This remark particularly applies to howitzers, which must be always pointed above the object; this is not the case with cannon, except when the object is beyond the point blank. Whenever we point above the object the piece masks it, and it is not possible to calculate the degree of elevation; the contrary is the case when we sight below the object, the degree of depression is easily found, and a few trials soon give the angle of projection: it will suffice then to find a means of firing point blank with howitzers and cannon when the object is beyond the natural point blank distance. This is effected by making *artificial sight*

lines, which give to howitzers a point blank, and in cannon carry it to the point occupied by the object.

If we imagine a vertical scale divided into small divisions, and placed at the cascable point of sight of the cannon or howitzer, and if lines be drawn between each point of division and the sight at the muzzle, then these will be artificial sight lines, more inclined towards the axis than the natural sight line, and making greater angles of sight; and consequently protracting the point blank to a greater distance than the natural point blank. We may accordingly select such an artificial line of sight, that the object will be found at its intersection with the trajectory. In howitzers, the artificial line of sight being inclined towards the axis, their fire is effected in the same mode as cannon.

Elevators attached to the cascable of cannon and howitzers.

To put in practice this ingenious conception, the elevator (*hausse*) has been perpendicularly affixed to the cascable of cannon and field howitzers. It is a copper scale sliding in a groove and fixed at any of its divisions by a small screw, and graduated by lines from the summit marked 0. Instead of dividing the elevator into lines or centimètres, it would be better to inscribe at each point of division, numbers agreeing with the distance to which the piece ranges under that elevation.

The firing of the musket is founded on the same principles as cannon. The French musket contains a ball of 20 to the pound; formerly the balls were 18 to the pound, and the cartridge was more perfect with respect to the accuracy of the fire.

Application of the preceding theory to the fire of musketry.

In the musket there are two sight lines, according as the bayonet is fixed or unfixed. The sight line of the musket with fixed bayonet, is less inclined towards the axis than when the bayonet is unfixed; whence it follows that the point blank in the first case being less distant than in the second, the fire by the first sight line is more uncertain and less effective than by the second: consequently it is most advantageous to fire in battle with the bayonet unfixed.

Original point blank and mean ranges of muskets.

The primitive point blank of the musket*, without the bayonet, is a distance of about 160 mètres (178 yards); and with

* This investigation sufficiently explains the vulgar error in which so many believe—*that the shot rises above the line of projection or axis of the piece;* this mistake could have only had its origin in the grossest inattention to the form and construction of cannon and muskets.

TRANSLATOR.

the bayonet it is only 90 to 100 mètres (100 to 111 yards); this shows that whenever the object is 160 mètres distant, we should take aim at it by the line of sight with the bayonet unfixed. If the bayonet be fixed, the object must not be distant more than 90 to 100 mètres to fire point blank: whenever the object is beyond these limits, we must aim higher to strike it; and when within these limits, we must fire lower than it. Consequently to strike an object distant about 350 mètres (390 yards), we must with the bayonet unfixed aim about 270 centimètres (9 feet Eng.) above the object; or about 340 centimètres (11⅓ feet), if the bayonet be fixed. Numberless experiments prove that if the horizontal line of sight be elevated above the horizontal 160 centimètres (5⅓ feet), the range of the ball will be about 300 mètres (334 yards) if the bayonet be unfixed; and if fixed, about 260 mètres (290 yards) only. Accordingly we may fix the mean range of the musket at 220 to 250 mètres (245 to 278 yards).

Important deduction.

It follows from the preceding, that the fire of musketry at great ranges is quite uncertain; for it is impossible to direct them with the necessary exactness; it is therefore in vain and a total loss, to make use of them in battle. We cannot lay sufficient emphasis on the importance of this rule, especially in applying it to the fire of intrenchments. Artillery pieces, from 4 to 24 pound calibers, range from 3,000 mètres (3,340 yards) to 4,500 mètres (5,000 yards); but their original point blank does not exceed from 400 (445 yards) to 600 mètres (670 yards). It is only by firing pieces at the distances fixed by experience for each caliber, that we can produce decisive effects and obtain results on which to calculate: these distances are included within limits, a knowledge of which is requisite to properly direct the efforts of artillery in the field of battle, or in the attack and defence of places.

The effective ranges of fire arms.

Maxim founded on experience in relation to the use of musket and artillery fire.

Reason, confirmed by experience, should induce us to receive it as an invariable rule, *Never to make use of fire, but within the distances established for effective ranges.* We have personally witnessed in many battles the grossest mistakes in this respect, that the importance of this rule cannot be too deeply impressed. In the attack on Spires, the artillery of a whole column uselessly expended all their ammunition before they were within 800 mètres (890 yards) of the enemy drawn up in order of battle in front of the ditches of the town.

TABLE

Of Mean Ranges of Artillery Pieces of all Calibers.

Calibers.	Mean Ranges in mètres.	Mean Ranges in yards Eng.
24 and 16 pounders .	1000 to 1200	about 1120 to 1340
12 and 8 pounders .	800 to 900	900 to 1000
4 pounders . . .	500 to 600	560 to 670
Field howitzers . .	400 to 500	450 to 560
Howitzers of great ranges	800 to 1000	900 to 1120
Mortars	600 to 1500	670 to 1670
Stone Mortars . . .	60 to 80	66 to 90
Grenades	20 to 30	22 to 34
Muskets	200 to 250	222 to 280
Rampart guns (*fusil de rempart*) . . .	250 to 300	280 to 335

This rule applies equally to the fires of infantry: if we do not regulate their use according to the distances fixed as the effective range of musketry, they will produce but very trifling results. If we open our fire while the enemy is yet too far distant, the shot will fall short and strike the earth. If the enemy be very near, and we neglect to fire very low, the balls will pass over their heads. The general rule is, to begin by firing high, and as you approach, depress and fire point blank: finally, when very near the enemy, you must depress the fire so low as to aim at the ground just in front of them. At the battle of Fontenoy, the two armies were so near when the firing commenced, that the officers in the opposite lines could hear each other speak, and the English officers were observed making great efforts to cause their men to fire very low; accordingly the first discharges did prodigious execution.

We will conclude our Essay on Gunnery by recommending to the students to consult those works that treat this part of the art in all its various details.

(See the tables in *L'Aide Memoire*, these of *Lombard*, and the *Artillerist's Manual*.)

51. The causes that influence the accuracy of firing, are the same that we have already stated (46), and which diminish the regularity of the motion of projectiles; they are almost entirely caused by the imperfection of the weapon producing deviations, &c. Among these causes we must particularly distinguish the windage of the ball in the piece, and which often alters

51. The principal cause that diminishes the accuracy of fire; the means proposed to remedy it.

the angle of departure; this alteration produces great inaccuracies in the fire. We have also seen that it diminishes considerably the initial velocity; and consequently the range.

Although, in the French artillery, the windage has been reduced to the smallest limit, yet it has still a very perceptible influence. Several means have been proposed to correct this defect, and the most learned and distinguished men have not disdained to devote to it their attention. Guyton Morveau conceived a very ingenious idea, which gave rise to some experiments whose satisfactory results confirmed the indications of theory. It is desirable that these experiments be repeated on a larger scale.

Guyton's ring balls.

This philosopher caused cylindrical balls to be cast terminating in front in semi-spheres, each ball having a groove near its hinder part or base, in which is fixed a rundle of lead exceeding the limb of the bore When the shot is rammed hard home into the piece, the limb of the bore cuts from the top of the lead the excess in the form of a ring, and thus the bore is exactly filled by the lead: the piece must, like a rifle, be loaded with a mallet. It is evident that by this means the windage being almost entirely suppressed, the angle of departure will be more accurate, and the initial velocity and range increased, or less diminished. Indeed some experiments have proved that the range increases nearly one third. The cylindrical form of the shot leaves us to apprehend great deviations; and this Doctor Hutton found to be the case by his experiments. But we require further experiments to throw light upon this subject.

The use of these ring balls would be very effective for the defence of fortresses, and of the sea coast, and in all circumstances where the firing is slow; but they are unfit for common use and occasions.

Delcassan's wooden wedges.

M. Delcassan, of Sedan, suggested in 1796 the idea of a circular wedge of wood rammed in over the shot. This wedge is placed in front of the ball, and introduced with it into the bore at the same time; it is then rammed over the ball; the limb of the wedge entering between the shot and the sides of the bore, occupies all the windage. The characteristics of the wedge are, closing up all the outlets against the elastic fluid, keeping the ball in the line of projection, and preventing its rotation while in the bore; and preserving the sides of the bore from the action of the mobile.

The experiments made with these shot, and which it is very important should be repeated, seemed to show that the wedge thus used does not produce the effect expected; probably in consequence of the shot and the wedge separating before they leave the bore, and the latter being broken and disfigured before the explosion.

A second method is to use a solid wedge in the form of a sabot, hollowed in such a manner that the shot may be rammed upon it when it is placed between the latter and the cartridge. In this manner the wedge becomes a species of sabot, lengthened and improved; and as easy to be used as the common sabot.

It is very difficult not to believe that this kind of wedge would produce the desired effect; it is much to be wished that it may undergo the test of experiments.

Finally, the inventor of these wedges proposed that the part of the bore which contains the wedge should be slighty hollowed, in order that by ramming it into this slight indentation, it may produce more decisive effects. But it is only by experiments that this rational expectation can be confirmed.

52. Definition of the several kinds of fire, and batteries, used in war.

52. The several modes in which cannon are fired in military operations, have given rise to distinguishing many kinds of fire; and the different methods of using artillery in war, have produced many kinds of batteries.

The direct fire.

The fire is *direct* (*à plein fouet*) when the gun being charged with the maximum, the object is struck in the direction of the trajectory; this term is also used when the fire is with one-third the weight of the shot, and the object at the *original point blank* distance.

Random firing.

Random firing (*le tir à toute volée*) is with the greatest charge and under the greatest angle that the carriage will permit.

Ricochet firing.

Ricochet firing is founded upon the property that projectiles possess of glancing in repeated bounds or successive ricochets when the angle of descent is as small as about 10 degrees. The smaller this angle is, the lower, longer and more numerous are the ricochets. This fire is with weak charges, found by a few trials, and is used with all kinds of projectiles, bombs, howitzes and ball. It is greatly used in the attack of places, and to enfilade the fronts of lines and heads of columns in the field; likewise to annoy and harass an enemy's camp or position. It is

to the celebrated Vauban that we are indebted for this terrible invention.

Definition of battery in general.

The term *battery*, signifies the whole power or number of many guns acting together and in concert to produce a certain effect.

Batteries, the direction of their fire with respect to the object.

Batteries are distinguished by the direction of their fire to the object battered, into, *direct* batteries, *oblique* batteries, *enfilading* batteries, *reverse* batteries, and *cross* batteries.

Direct batteries, are those whose line of fire is perpendicular to the front of the fortress or line battered.

Oblique batteries (*batteries d'écharpe*), are those whose lines of fire are very oblique to the troops or place, and which make with the latter an angle of 20 to 30 degrees.

Enfilading batteries, are those whose trajectories are in the same vertical plane with the front of the fortress or troops.

Reverse batteries, are when the fire strikes the *rear* of the troops or fortification.

Cross batteries (*batteries croisées*), are when the lines of fire cross each other at the points battered.

Batteries distinguished into fixed and moveable.

Batteries are also distinguished into *fixed* and *moveable*. *Fixed* batteries are such as are used in intrenched positions, and in the attack and defence of places. *Moveable* batteries are used in battles and operations, and are combined with the manœuvres of troops.

The epaulments of fixed batteries.

Fixed batteries are covered in front by a bank of earth called an epaulment; this latter is itself called a battery; but as its construction appertains to fortification, we will postpone our consideration of it 'till we come to treat of this latter branch of war.

We will here conclude for the present these general principles of artillery, which we will more fully illustrate and develope in that part of our work devoted to the theory of fortification, the great object of our treatise.

CHAPTER VIII.

Castrametation.

Preliminary remark.

WERE we to pursue the most methodical course, we should now treat of fortification, in order to complete the particular descriptions of all the constituent elements of an army, and bring them all simultaneously into action, making each arm partake in the more or less complicated operations of a plan of campaign. We would pursue this course, if the present Treatise were a general exposition of military science; but as our principal subject is fortification, we must regard the other branches of war as preliminaries, a knowledge of which should precede and facilitate the study of the former.

53. Castrametation in general: of camps.

53. *Castrametation* is that part of military science which teaches the disposition of the troops composing an army on ground where they are to take post to fight, or from which to march to another position.

This disposition of an army is called *a camp.*

Principles of encampments

The principles of the art of encamping troops result from the order in which an army should form when supposed to be opposed and acted against in front by another army; regard being paid to the salubrity, and essential conveniences of the position.

Order of an army before taking up its camping-ground.

An army should always form, even in camps of instruction, as if it were in the presence of an enemy who might suddenly attack or obstruct its operations. The precautions dictated by prudence should be observed; and the operation of encamping is protected by the display of a defensive disposition in front of the ground to be occupied by the camp.

Detachments of cavalry, dragoons, and light infantry, precede the army and occupy all the posts that cover the camp. As soon as the army arrives, and a general reconnoissance of the ground is made, it puts itself in battle array, displaying its front and lines in regular or irregular order according to the plan of the General.

By this formation the different corps know the respective positions that they are to occupy in order of battle in case of attack.

Order of encampment deduced from the order of battle

It follows, that the order of encampment is subordinate to that of battle, and is deduced from a knowledge of the latter, which is determined by the plans of the General.

Marking the colour line.

As soon as the army has formed line, the chief of the general staff marks the colour line (*le front de bandière*), which is the line of the head of the camp, and on which the first row of tents is pitched.

Front and extent of the colour line

There should be between the front and extent of the colour line, and the line of battle, such a distance that the various corps can easily debouche* from their respective camps to quickly form in front of the colour line, and from thence take post on the line of battle in order and without confusion. Consequently, *the extent of the colour line, and of the line of battle, should be about parallel and equal.*

Regular encampments.

In *regular encampments*, the parallelism and equality of length of the colour line, and of the line of battle, is accurately established.

The composition and ground plan of a general camp.

The general camp of an army, consists of the particular camps of the several arms; and its ground plan is composed of those of the different corps along the colour line. Accordingly we must determine the figure and ground plan of the camp of the unit of force of each arm; viz: of the battalion, the squadron, and the division of horse and foot artillery.

Description of a tent (See PLATE VI. fig. 5: and the last regulations for encamping.)

We all know that the tent is a canopy or covering for soldiers, made of several pieces of linen sewed together, and spread out and supported by a kind of trestle, and its lower edges fixed to the ground with pins. The supporting trestle is composed of an upright pole about 20 decimètres high ($6\frac{3}{4}$ feet), and a cross piece 18 decimètres (6 feet) long, to the middle of which the upright is joined; they are united on each side by bracing pieces that strengthen the whole frame: the cross piece forms the ridge of the tent.

* *Debouche* is lately introduced into English, being the personal of the verb *deboucher*. It means the movements of columns or heads or parts of columns, particularly out from narrow roads, passages, defiles, or across bridges; hence we say the army is debouching from the defiles of the mountains, or over the bridges, or from the Brussels road, &c. The distinction between this verb and *to defile*, is that the former applies to columns or masses with considerable fronts, whilst the latter strictly applies only to the flank movements of lines, platoons, &c. The substantive, *debouché*, is the pass, road, outlet, or defile, from which troops may debouche. TRANSLATOR.

There are in the public stores two kinds of tents; the old, and the new models. The old model terminates square on one of its small sides, and in *cul de lampe* on the other; its horizontal projection is a mixed rectangle in length 3 mètres .35 (about 11¼ feet), by 2 mètres .60 in breadth (8¾ feet): the door of the tent is on the small plane side opposite the *cul de lampe*. Each of these tents contains eight men.

The new tents are of still greater dimensions, being exactly 5 mètres .85 long (19¾ feet), by 3 mètres .90 broad (13 feet), and contain at most 15 or 16 infantry men, or 8 horsemen or artillerists. Two of the sides of these tents are in *cul de lampe*, and the door is on one of the long sides. As our subject is only general principles, we will suppose the horizontal projection of this latter tent to be a mixed rectangle of 6 mètres (20 feet), by 4 metres (13⅓ feet); and that the two small sides in *cul de lampe* are bounded each by an arc of a circle.

Length of the camp of a battalion or regiment of infantry; manner of placing the tents

The length of the colour line of the camp of a battalion or regiment, is regulated by and should equal the extent of front in order of battle. It is therefore obvious, that the camp should be laid out agreeably to the habitual order of battle of the battalion in three ranks. Accordingly, and the strength of the battalion being as stated (art. 36), the front of the camp should be 178 mètres (200 yards) long, including the grenadier company, or 163 mètres (182 yards) excluding this company. Every arrangement of tents should fulfil this prerequisite, and should allow the troops to defile from all parts of the camp, without confusion, to form at the head of it. The mode of disposing tents now practised, possesses these characteristics; and also the greatest simplicity. The tents are in files perpendicular to the front of the colour line, which is supposed to be accurately traced by the aid of a line; so that the outlets of the tents are upon the perpendicular. When the old tents are used, their roofs or long sides are parallel to the colour line; but in the new tents they are perpendicular to the front.

Each file of tents contains a section or half company, or even a whole company if the battalion be weak; the files are separated by lanes and streets of proper breadth, making the whole length of the colour line equal to that of battle.

Encamping by files of tents containing a platoon or company, is used, whatever may be the strength of the battalion, when the position is narrow, or when the General intends to fight in

Disposition of the tents in a battalion camp; length of the colour line.

two lines or in deep order. If the grenadier companies are detached to form together in corps, they establish a separate camp on the ground assigned to them. But we will suppose that each battalion has its grenadiers with it, and that they are encamped on its right in the interval between the two adjacent battalions: likewise, that the camp is pitched with tents of the new model; we will therefore place 4 in a file capable of accommodating 60 men, who would require 8 tents in file of the old model. The 8 battalion companies being formed into 16 sections, answering to the 16 files of tents, the perpendicular line is traced on the right of the camp with the help of the *perpendicular cord*, and on this the first file of tents is established at a distance from each other of about 2 mètres ($6\frac{2}{3}$ feet); another file is then established on the left wing in the same way; the openings of the tents in both, are towards the interior. There then remains 14 files to be disposed along the front, and between the two flank files already established. These are set back to back, or against each other by two's, separated by lanes 2 mètres ($6\frac{2}{3}$ feet) wide. Thus there will be 7 double rows of tents placed upon each other with their doors towards the exterior, and distributed equally from right to left; and forming 8 large streets by the sections of the same company, and whence these sections may defile with facility to form at the head of the camp. This simple and general disposition is applicable to all cases. We would remark that in this general plan, the width of the great streets is the only variable quantity; and is found by subtracting from the length of the front of the camp, founded upon that of the line, the constant quantity 78 mètres (87 yards), and dividing the remainder by 8, the number of great streets. If we apply this rule to the battalion on the war establishment, which we have taken as the unit of force, and the length of whose front in battle is 163 mètres (182 yards), then the length of the camp would be 158 mètres (176 yards), and the breadth of its great streets 10 mètres (11¼ yards).

(See PLATE VI, fig. 2)

When the strength of the battalion is successively decreased to 500.

If the encampment be by files of tents containing each one company, so as to reduce its front to about half the line of battle; there will then be only three double rows, back to back, and four great streets; and the length of the colour line will be 78 mètres (87 yards).

When the strength of the battalion is reduced to about 600

men, the encampment is still by files of tents containing a section; the number of tents in the file, and the width of the streets, only being reduced: the latter is sufficient, provided it is not less than 5 mètres (5⅔ yards). Thus, if we suppose the battalion to be 720 strong, the camp would be disposed as we have already described, subject to two modifications; 1st, there would be only 3 tents in the file, because the section is composed of but 45 men; 2d, the great streets would be reduced to 7 mètres (8 yards nearly); but the front of the camp would be 134 mètres (149 yards), nearly equal to the front of the line, which would be 136 mètres (151 yards).

But if the numerical force be decreased to near 500 men, then the camp must be by files of tents, containing each one company or platoon. For instance, suppose we have to encamp a battalion of 464 men, displaying a front of 80 mètres (89 yards), we would make the front of the camp 86 mètres (95½ yards); and by thence subtracting the constant quantity 38, we have for the width of each of the four great streets, 12 mètres (13⅓ yards).

Line on which the arms are stacked.

The line of the centre of the stacks of arms is parallel to the colour line, from which it is 10 mètres (11 yards) distant in front. The stack for each file of tents, is on the prolongation of the great street.

Disposition of the kitchens; of the officers' tents; and of the sinks.

The kitchens are in a line about 12 mètres (13⅓ yards) in rear of the soldiers' tents; next beyond are the tents of the sergeant major, drum major, suttlers, washerwomen, &c.; then the line of tents of the lieutenants and sub-lieutenants; in rear of these again are the tents of the captains; and lastly the line on which are pitched the tents of the colonel, major, chief of battalion, surgeon, &c.: the whole disposed as laid down in Plate VI, fig. 2, in which the various distances of the respective lines of tents are given.

(See PLATE VI, fig 2.)

The sinks for the soldiers and officers are on the axis of the camp; those for the former, are 110 mètres (122 yards) in front of the colour line; and those for the latter, 30 mètres (33⅓ yards) in rear of the officers' tents.

Depth of the camp.

By adding together all the distances from the stacks of arms to the tents of the staff officers, we find the depth of the camp to be about 116 mètres (129 yards).

Encamping of regiments and brigades of infantry.

In this manner regiments and brigades of infantry are now encamped without difficulty; care being taken to leave be-

tween the battalions of regiments, and the regiments of brigades, the necessary intervals; so that the whole length of the colour line shall be about equal to that of the line of battle. Thus, if the camp were formed on the two first orders of battle in Plate III (second part), the camp formed on the first must consist of the camps of the several battalions in a line upon each other, and without intervals. But the camp formed on the second order, must be with intervals of 20 to 30 mètres (22 to 33 yards) between the battalion camps, and 30 to 40 mètres (33 to 44 yards) between camps of regiments. In fine, the arrangement of an encampment is ever subordinate to the order of battle.

Camp of a squadron or regiment of cavalry. (See PLATE VI, fig 3)

Camps for cavalry are formed on the same principles as infantry camps, and by an union of the camps of several units of force or squadrons. The camp of the squadron must possess the two pre-requisites already established, besides having sufficient room for stabling the horses and forage. These conditions are obtained by encamping by half companies or platoons. Two files of tents mark the wings, whilst the two others are placed back to back on the centre of the front, with a lane between them of 2 to 3 mètres. Consequently the camp of a separate squadron will have one lane and two large streets; the width of the former does not vary, but that of the latter does; the latter should never be less than 20 mètres (22 yards), a width essential to picket two rows of horses, and to defile with facility.

Therefore, if we know the front of the squadron in line, and subtract from it the constant quantity 18 mètres (20 yards), and divide the remainder by two, the quotient will be the breadth of the streets, which should never be less than 20 mètres. When the strength of the squadron is so reduced that the breadth of the streets would be less than 20 mètres, the camp will then be by files of tents containing a whole company. The camp of the squadron will in this case consist of only two files of tents, making one street.

By applying these principles to the squadron of cuirassiers whose front (36) is about 88 mètres (98 yards), we find the width of the streets will be $\frac{88^{mt} - 18}{2} = 35$ mètres (40 yards).

When the front of the squadron is less than 60 mètres.

If we suppose the front of the squadron in battle to be 60 mètres (67 yards), the width of the streets will then be only 21 mètres (23½ yards), or nearly that extreme beyond which

it cannot pass. So that, if the squadron front were only 54 mètres (60 yards), the breadth of the streets would be only 18 mètres (20 yards), which is against the rule ; therefore the squadron must in such case be encamped in two files of tents, each containing a company and about 46 mètres (51 yards) apart.

Dragoon camp.

What we have said respecting the cuirassiers, is applicable to the squadron of dragoons, with the addition at the head or rear of the rows of tents, of three or four more tents for the dismounted dragoons (*dragons à pied*), who form one third of the company on the war establishment.

Mode of contracting the camp of a squadron.

There are two ways of contracting the squadron encampment, according to the intentions of the general, or the ground ; 1st, by diminishing the width of the streets to the narrowest limit of 14 to 15 mètres ($15\frac{1}{2}$ to $16\frac{2}{3}$ yards) ; 2d, by encamping in files of tents containing a company.

Number of tents in the file or row.

The number of tents in a single or double row, depends upon the numerical force of the company, each tent lodging 8 horsemen. Thus for a squadron of about 144 men in file (art. 36), there would be five tents in the row, or eight in the two files belonging to the company; these are sufficient to lodge all the men. When the force of the company is decreased, the double file is one tent less, or each file is composed of three tents only.

Distance between the tents in the direction of the perpendicular or axis of the camp. (See PLATE VI, fig. 3.)

The most convenient place of deposite for the piles of forage, is the space between the tents facing the centre of the camp ; accordingly the tents are distant apart about 5 mètres .2 to 5 mètres .5 (nearly 6 yards), except the two last, which are separated double this distance or 10 mètres .4 : by this arrangement the horsemen of each tent have their quantity of forage under their hands. The horses are picketed opposite the forage, as shown in the plate.

Lines, of the stacks of arms, of the kitchens and sutlers, of the tents of officers, &c. ; of the sinks,

The line of the centres of the stacks of arms, is parallel to and 10 mètres in front of the colour line : these stacks are arranged as in the infantry.

The distance from the *culs de lampe* of the last tents in the files, to the line in the centre of the non-commissioned officers' tents, is 8 mètres (9 yards) ; from the latter to the line of kitchens, it is 16 mètres (18 yards) ; from this to the line of tents for the corporals (*brigadiers*), artificers, sutlers, &c. is 18 mètres ; thence to the central line of the tents of the lieutenants

and sub-lieutenants and sergeants major, is 16 mètres; thence to the captains' tents, is also 16 mètres; and from this latter line to that of the tents of the colonel, major, chiefs of squadrons, adjutant, and chief surgeon, is 20 mètres (22 yards).

The sinks (*latrines*) for the soldiers are in front of the centre of the camp, 66 mètres (73 yards) from the colour line; those for the officers are in rear, 36 mètres (40 yards) from the last line of tents.

Depth of the camp.

Adding together all the distances from the stacks of arms to the line of staff tents, we find the depth of the camp to be 130 mètres (145 yards).

Encamping of regiments and brigades of cavalry.

The camp of a regiment of cavalry is formed by placing on each other successively, the separate camps of squadrons composing it. In the same way is formed the camp of a brigade, by setting upon each other successively the camps of its component regiments, separated by intervals great or less, according to the order of battle, the plans of the general, or local circumstances. Thus, if we had to encamp the wings of cavalry of an order of battle, such as fig. 1. Plate III, (second part), the regiments should be encamped without intervals. But for an order of battle like that in fig. 2, there must be 20 to 30 mètres (22 to 33 yards) of interval between the camps of regiments, and 30 to 40 mètres (33 to 44 yards) between those of brigades. In either order, the interval between the cavalry and infantry camps, should be about 50 mètres (55½ yards): finally, the general order of separate or particular camps, is according to the order of battle, or local circumstances.

Horse and foot artillery encampments.

The artillery encamp on positions by divisions, and even by half divisions. The camps of foot artillery are in rear of the infantry encampment, whilst the horse artillery encamp behind the cavalry, or in rear of the wings. The artillery moves from its separate camps to the positions in line of battle. The order of encampment of divisions of foot or horse artillery, is nearly the same: we will describe that of a division of horse artillery; which is easily modified into a camp for a division of foot artillery.

Composition of a division of artillery served on foot or on horse.

To form the camp of a division of artillery, we must know all its component elements; they are displayed in the following table.

TABLE,

Exhibiting the Composition of a Division of Artillery.

		Number of men.	Number of carriages.	Number of horses.
Cannoniers	In the company on foot .	54		
	In the company on horseback	66		66
Companies of the train (wagoners and drivers)		80 } 146		
6 pieces of artillery	8 pounders		4	24
	6 inch howitzers . .		2	12
2 spare carriages	for 8 pounders . . .		1	4
	for the howitzers . .		1	4
14 caissons	for 8 pounders . . .		8	48
	for the howitzers . .		6	36
3 carts, for	spare implements, &c. .		1	6
	the company of the train		1	6
	the company of artillery		1	6
2 forges, for	the artillery . . .		1	6
	the train		1	4
Totals			27	222

Twenty-four tents are requisite for the company of the train in consequence of the great quantities of equipage and implements that they carry with them, and which must be sheltered; 8 tents are necessary for the cannoniers, making in all 32 tents for either division.

Number of tents necessary for encamping the cannoniers, &c.

The encampment is composed of 4 separate camps, A, B, C, D, whose fronts are parallel to that of the infantry or cavalry, behind which they are placed.

Figure of the camp (See PLATE VI, fig. 4.)

The two camps, A, B, distant from each other about 64 mètres (71 yards), are formed by two files of tents perpendicular to the front and in depth about 40 mètres (45 yards); the tents are at such intervals from each other as to leave room for the heaps of forage. The street between these two files will be 20 mètres (22 yards) wide, with two rows of pickets to which to attach 52 horses. The space of 64 mètres between the two camps, is for receiving the 27 carriages, ranged in three ranks as laid down in the plate.

At about 14 mètres (15½ yards) from the third row of car-

riages, and perpendicular to the central line of the camp, the two camps C, D, are established on each other, with the same front and depth as the two others. In rear of these two last camps, is the line of tents for officers; and behind them are the sinks.

The 3 separate camps A, B, C, are for the train, and each relates to the three rows of carriages; the camp D is for the mounted cannoniers.

Modification of the camp of the division of horse artillery, to make it answer for foot artillery.

We see that the three elementary camps A, B, C, are common to the division of horse, as well as foot artillery; but for the latter it will be sufficient to make the width of the street in D, 5 to 6 mètres ($6\frac{2}{3}$ yards) only.

Mode of marking out the ground into camps for the different arms. (See Instructions for Encampments, published by order of the War Minister, in 1201.)

We do not enter into the details of tracing the camp upon the ground, referring on these subjects to the last admirable compilation of Instructions for Encamping, published from the *Depôt General de la Guerre**, by order of the Minister of War. If we have already deviated in some points from the purpose of our work, it is solely because we have restricted ourselves to exhibit general principles only: we however consider it a duty to pay homage to the talents and labours that direct that admirable institution.

Camps are marked out with three lines or cords, which are always part of the equipage of a regiment, and are called the *front line*, the *depth line*, and the *small perpendicular line;* the divisions marked on the two first enable us to find immediately the divisions of streets, lanes, &c. and the third shows the fronts of the squares.

Tracing the general camp of a division of an army. (See PLATE VI, fig. 1.)

It is now very easy to deduce from the general rules that we have established, and to trace out, the general camp of a divi-

* "*Depôt general de la Guerre*," an office in the French War Department charged with collecting, compiling, and publishing instructions in all species of tactics, topographical maps and plans, commentaries, and essays upon the attack and defence of frontiers and countries, criticisms upon celebrated battles, sieges, and campaigns; and in fine with every labour that can enlighten present and future military operations. This Department is with respect to the science of war, what the National Institute is in relation to the arts and sciences in general—the temple which receives, condenses, and reflects back with concentrated lustre and effulgence, the dispersed learning and discoveries of past and present generations.

The want of such an appendage to the American War Department, to collect and preserve maps, plans, and memoirs, &c. has been, and will be further *severely felt*. TRANSLATOR.

sion of an army, consisting of 12 battalions, 2 regiments of cuirassiers, and 2 regiments of dragoons. We begin by putting the division in a regular order of battle, supposing the infantry to be in the centre, and the cavalry on the wings. The ground being supposed perfectly uniform, we mark out in rear of and parallel to the line of battle, the direction of the colour line, on which we establish perpendicular lines corresponding to the centres of the various corps of infantry and cavalry. These become the centres of their respective camps, which being laid out in the manner described, form a general camp that has the most direct relation to the line of battle.

If the order of battle of the division, instead of being like the first and second orders in Plate III (*2d part*), were the third order, the encampment should be modified accordingly. Thus, after having established along the front of the colour line, the central lines of battalion camps, these camps must be established on these lines and contracted as much as possible. About 50 mètres (56 yards) behind the infantry encampment, and facing the battalion intervals, the front of the colour line of the squadrons will be traced. By this simple arrangement the corps can pass without confusion from the order of encampment into order of battle.

Exclusive of the posts occupied by the advanced guards, flanking corps, &c. on the front and flanks of the camp, it is surrounded by guards daily relieved, to prevent parties of the enemy or spies from penetrating in, and producing mischief or disorder.

Redans on the front and flank of the whole camp, and in which the main guards are stationed.

The main guards are posted in redans constructed opposite the centres of battalions, and about 160 mètres (178 yards) from the colour line. The salient angles of these redans are about 80 degrees, and the length of their faces is nearly 10 to 12 mètres (11 to 13⅓ yards); we will describe their profile in the second part.

Each battalion sends 10 men as a guard to the redan; and from this main guard 3 men are detached forward 50 mètres (55½ yards), and furnish the outmost sentinels (*sentinelles perdues*) stationed 80 mètres (89 yards) farther in advance. In case of alarm, all the sentinels and advanced guards fall back upon the main guards; and the whole then retire upon the army, that has had time to form in front of the camp*.

* The guards, in retiring upon the camp, should be careful to retire

Irregularities of general encampments.

The irregularities of general encampments are occasioned by irregularities of ground, and the composition of the order of battle, which local inequalities generally render more or less complex. The application of general principles to particular cases, depends upon the *coup d'œil;* a talent that modifies according to the various circumstances, the maxims and precepts of theory.

upon the extreme flanks of corps or of the camp, and not directly upon the fronts of regiments or battalions; for this would prevent these troops from using their swords or fires to repulse the advancing foe. The guards should retire slowly, and dispute every foot of ground, in order to give the army time to form in order of battle; for this purpose they will halt often, convert every hedge and ditch into a defence, and use their utmost skill and valour to delay the enemy's advance.—See *Essai sur les Troupes legeres,* par le General Baron Allen.

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CHAPTER IX.

Military Topography; General and particular Maps; Reconnaissances; the several kinds of War; General Disposition of an Army on a Frontier; Military Positions; Lines of Operations; Positions of Batteries; Principal Operations in the course of a Campaign.

Consideration of the knowledge of countries requisite to projecting operations, &c.

WE are now to consider the preliminary and indispensable knowledge of the features and resources of a country, before bringing into the field the armies charged with executing the plan of campaign. This knowledge of the countries that are to be the theatre of war, not only decides the nature of the war, but also the composition of the armies.

54. Military topography: its importance.

54. These features or preliminary data, are called *military topography;* and consist in general in the knowledge of a country under the various relations of attack and defence, and of all its resources to attain the object of the war. This knowledge is inestimable to him who projects the war and plan of campaign, and to the general who executes it. All the great captains of ancient and modern times have testified the great importance of this branch of the science, which, combined with tactics, is the touchstone of the *coup d'œil* and genius of a General. If we examine closely the causes of victories and disasters, we will find that they may be entirely referred in almost all battles to a more or less profound knowledge of the properties of the ground, and its influence on the mutual efforts of the troops. Alexander the Great had always engineers preceding his army, to reconnoitre the country; and he constantly derived great advantages from the accidents of ground. Epaminondas, whose name recalls the recollection of the brightest virtues and rarest military talents, made reconnaissances in person of countries and positions; his orders of march and battle were always formed according to the nature of the ground. Xenophon, whose writings so deeply interest the reader, studied topography unremittingly; and we imagine that we behold in his retreat of the Ten Thousand, a French division commanded by a Desaix, with an able staff and engineers. Xenophon remedied every evil, attended to all, and

foresaw every thing by his *coup d'œil;* and crowned himself with immortality. It was a profound knowledge of a difficult, broken, and mountain country, that enabled Fabius to conceive the possibility of putting a period to the conquests of Hannibal, the greatest General that perhaps ever existed. Hannibal himself owed the conception of his plans and the wisdom and valour of their execution, to an intimate knowledge of ground. It was reserved to Napoleon, to exhibit to astonished Europe a second example of these talents. Cæsar, who was at the same time an able engineer and consummate General, studied attentively the nature of the country in which he was making war, and seized with admirable dexterity the least irregularities of positions. History consequently teaches us, that the Generals of antiquity attached the greatest importance to military topography, and that they profoundly studied it in all its details; but not having like the moderns the aid of the mathematical sciences and graphic arts, and their mode of warfare not requiring so great a display of front, it remained in its infancy, and perished amid ages of barbarism and ignorance.

Henry IV, inspired by his native genius and the difficulties that surrounded him, exhibited on many memorable occasions the advantages to be derived from the science of positions, and from the knowledge of a country well reconnoitred and occupied by posts judiciously situated. At last, in the seventeenth century, the princes of Nassau and a great number of illustrious captains, revived the true principles of war; and far extending the science of posts and positions, transcended in this respect the great commanders of antiquity. The princes of Nassau, the Turennes, the Montecuculis, the Luxembourgs, the Catinats, the Vendomes, the princes of Savoy and of Orange, the Crèquis, the Villars, Count Saxe, and the great Frederick, and others, would not have emblazoned their names with so much glory, had they not possessed the talent of reconnoitring countries and knowing the strength or value of positions. If they have at times sustained checks and disasters, it was almost always because they had neglected to make proper reconnaissances of important points.

All military writers consider topography so essential, that without its light, the first step must plunge us into a labyrinth, in which, however perfect may be our minute tactics, no combined movement can be executed.

Montecuculi, Feuquières, Puysègur, Folard, Turpin de Crissé, Lloyd, Guibert, &c., are unanimous on this point, which the least reflection on the conduct and movements of an operating army will make self-evident. These authors, animated by the most expanded views and best theories, produce numerous battles and actions in which we behold military topography exercising a decisive and distinguished influence; and where tactics are only employed to place the troops in relation with the ground. We find by their descriptions, which charm, instruct, and inflame the young student, that a knowledge of ground forms the General's rule of conduct; and that victory or defeat are the consequences of the *coup d'œil* which discovers, or does not perceive, the influence of the ground upon the contest.

Difference of topography among the ancients, and among the moderns.

The ancients must have beheld topography in a point of view different from the moderns; 1st, because they had not the help of geometry and descriptive drawing; 2d, because their operations did not embrace such extensive theatres of action; 3d, because from the nature of their weapons, the features of the ground did not possess so marked an influence on their effects.

The sphere of action of armies is now so enlarged, that several distinct armies acting on different frontiers, are but as divisions of one grand army, connected by intermediate relations, and combining their operations to a general result. How would it be possible to conceive such a combination, without general and minute topography exhibiting the several positions, the facilities of marches, and means of subsistence? Without a perfect knowledge of Alsace, could Turenne, in 1674, have passed the Vosges, and by the most admirable concert of several attacks have carried at the same moment all the quarters and cantonments of the allied armies of the empire and of Brandenburg, and gained the battle of Mulhausen? Would the innumerable victories gained by France since the battle of Houdscoote have illustrated her annals, if her Generals had not extended the science of reconnaissances? The battles and operations that we shall hereafter describe, will complete our conviction of the importance of topography, and show how essential it is to not only officers of the staff, engineers, and artillery, but even to those of the line; all of whom should study the theory and practice of this most important branch of war.

55 Definition of a frontier subject to become a seat of war.

55. *A frontier* is the country or boundary separating two states that maintain their political relations by force of arms. It is on this territory, of greater or less breadth, that all the preparatory dispositions for operations and battles are made.

Natural and artificial strength of frontiers.

The natural strength of a frontier is determined by its topographical features, which show the advantages afforded for attack or defence, for communications, subsistence, and resources of all kinds. The artificial strength of a frontier, is the modifications effected on ground by labour and art, to fit it for attack and defence. These modifications include all the works and dispositions made by artillery and fortification on military sites or positions.

56. Topography generally; manner of acquiring the knowledge of it.

56. All the particulars required in war, are comprehended in the military topography of the frontiers of the nation, and of the enemy's country. It consists in many parts, which united form a whole, more or less perfect according to the talents of

General maps.

the agents who survey the ground. The first labour is to form general maps exhibiting the topography of positions, and established by the military and geographical engineers, by geodesic and astronomical operations. This first plan accurately exhibits the respective situations of places, the summits of principal mountains, the courses of streams and rivers, and of their tributaries. When there is not time enough to make such a plan, including the principal triangles accurately determined, a supplctory mode is adopted of rapid operations and approximations, which the time, talents, and circumstances will suggest to the engineers.

Minute maps constructed by means of geodesic operations and descriptive and imitative drawing.

From general maps which exhibit little but mathematical lines, we come to minute topography or making of detailed maps in which the sides of the principal triangles are taken as bases. This second plan has not the accuracy of the first, and is obtained by approximating operations more or less correct and expeditious, according to circumstances and the time that the staff or engineer officer can devote to the work. Sometimes he uses instruments to determine the position of places, to measure distances exactly, and to delineate with precision the figure of the ground and its inequalities ; at other times he is constrained to ascertain the distances by the pace of a man or horse, and to lay down the figure of the ground by the most expeditious methods ; and sometimes the draught is made by the eye, without any other aid than intelligence and the *coup d'œil.*

The use of this second kind of draught is not only to determine the respective positions of places included in the great map,—the course of streams, summits of mountains, and roads, and paths, &c.; but to exhibit to the eye a picture of the surface and form of the ground, the generating of mountains, the sources and direction of streams, the formation of vales and valleys, general and isolated slopes, morasses, woods, roads, canals, &c.; and all the features and particulars connected with attack and defence. It is by descriptive drawing and conventional signs that we thus represent nature in all her various forms. Nature, even in her wildest features, is governed by certain laws, which are perceptible to an attentive observer; and from which an officer may derive great assistance when he is obliged to deduce from the visible parts, a general knowledge of parts concealed and invisible. In cases where descriptive drawing fails to properly represent certain features that greatly diminish in the horizontal projection, the officer must avail himself of imitative and perspective drawing; inestimable talents, acquired by a proper theoretical education, and by the skilful use of which the science of reconnaissances is perfected.

Memoirs descriptive and military.

To these maps are always joined *descriptive memoirs*, and sometimes *military memoirs*. The first describe in a plain and concise manner, all objects that cannot be well represented in the map, and those which could not be introduced; such as the nature of mountains of various declivities and slopes, morasses little or not at all practicable, woods more or less thick and of what nature, and whether fit for building, the fords and their nature, the fertility of the soil, the kinds and quantity of forage that the country can furnish, the population of its villages and the number of labourers, the nature of the roads and the repairs that they require, the number of horses that may be supported in the country, the means of transportation of all kinds, the commerce, industry, and customs and usages of the country, &c. &c.

The military memoirs accompanying maps of reconnaissances, should be composed by officers well acquainted with topography and skilled in the sciences of war, of posts and positions, of fortification, and of attack and defence. These latter memoirs alternately suppose the existence of an offensive and defensive war, and under this double view examine the fitness of the country for the purposes of attack and of defence; deter-

mining upon positions, offensive and defensive; examining their strength and defects, and discussing the kinds of works that should be erected upon them to attain certain objects. The intrinsic value or strength of the strong places is likewise investigated, and their relation to military positions, and the means of uniting them in one defensive system. The points by which one or two positions may be turned, are designated: also the mode of seizing these points by intrenched camps, small forts or redoubts, and of securing the flanks of these positions, or uniting them by this kind of chain.

The courses of streams, rivers, and brooks are examined; likewise the obstacles formed by lakes, ravines, and slopes. The proper points where bridges should be established, and the *têtes de pont* to cover them, are laid down. Finally, on the supposition of operating armies, the course of operations and battles, which it is presumed on certain hypotheses must take place, are detailed.

Reconnaissances.

Such are the principal details required by war, and which are called *reconnaissances*. We see that a complete reconnaissance demands the application of astronomical, geodesic, and physical acquirements; besides perspective, and imitative, and descriptive drawing, &c. Officers who make reconnaissances, should study physical geography, which has been treated and illustrated in the Polytechnick School by those superior talents which for 25 years have distinguished the learned professor of this branch of science.

Physical geography.

The surface of the earth when seen from a great distance, may without any sensible error be considered as that of an ellipsoid. All other planets in our system, when viewed through telescopes, appear of the same form. But to man, living on the surface of the earth, it appears very irregular, broken, indented, and elevated; furrowed by torrents, crossed by rivers, and the greater portion covered with water. At the first sight, all is chaos; the imagination is bewildered. But when the contemplative geologist, the naturalist, and the geographer, examines this surface with care, he finds that the difference between the level of the sea, and of the highest mountains, though of no sensible importance in relation to the radius of the earth, is yet of great magnitude with respect to man. He beholds all parts of the globe intersected by lofty primitive mountains, from which descend secondary mountains, and from these pro-

ject branches or ridges spreading and declining into hills and hillocks, and finally sinking into plains. From the loftiest, to secondary mountains, and from these to hills and hillocks, and down to the sea, there are general and isolated slopes, governed by certain laws of nature; and in consequence of which, all the parts tend to the formation of general and particular basins, vales and valleys, gorges and defiles, and the slightest undulations.

The contemplative mind will not be at a loss to discover the physical causes of all these changes and irregularities upon the surface of the earth; they exist in the phenomena of meteorology, and chiefly in that striking property of the atmosphere to decompose water by a rapid succession of changes that it undergoes, and which falling afterwards upon the tops of mountains and other parts of the earth, produce dilatations and degrees of temperature more or less elevated. It is by studying closely the effect of rains, which form fountains, torrents, and the tributaries of streams and rivers, that the topographical delineator is enabled to comprehend the various forms of the sites and positions that he describes.

It is not within the scope of this treatise to treat upon reconnaissances; the students and reader are referred to the 3d and 5th Nos. of the Topographical Memoirs, for the geodesic part, and for the conventional signs used in descriptive drawing; and to the essay contained in the 4th No. on the Theory of Military Reconnaissances; these they should study with attention. The author of that work has acquired by it a claim to the thanks of the army. The judgment is expanded and improved by the admirable principles with which his work is replete, and which, though too concise, possesses a simplicity and elevation of style that charm the imagination and enlighten the mind.

(See 3d, 4th, and 5th Nos. of the Topographical & Military Memoirs)

57. The composition of an army to operate upon a given frontier, is founded upon the kind of war to be undertaken, and the topography of the scene of action. A well disciplined infantry may in cases of extremity alone suffice; yet without artillery it would be difficult for it to resist an army seconded by this arm; and without cavalry, convoys would be very difficult, foraging almost impracticable, and victory ever incomplete, because it could not be followed up. Therefore, the constituent elements of an army should be combined in due proportion to each other.

57. Formation of an army to operate on a frontier.

If the seat of war be a plain country, woody, and abounding in forage, one-fifth or one-sixth of the army should be composed of cavalry, with numerous horse and position artillery. But if it be difficult and mountainous, wooded, and but little open, only a few cavalry are necessary, and scarcely any heavy cannon; but large corps of light infantry, and many light pieces, are requisite. In all cases where sieges are intended, there must be a park composed of battering pieces, mortars, howitzers, stone mortars, &c.

58. Two kinds of war.

58. War is divided into two kinds, *offensive* and *defensive*, according to the object to be attained. The *first* is when an army is almost always on the offensive; the latter is when an army is almost always on the defensive. If a general pass his own frontier and endeavour to force the enemy to battle, laying the country under contribution and besieging fortresses, and finally maintaining his conquests; then he carries on an *offensive war*.

Offensive war and the mode of conducting it.

The conduct of this kind of war, which is the most advantageous, depends upon the genius and enterprise of the general, the nature of his troops, and many other circumstances; all which must be known to project the plan of it. Sometimes he must march rapidly upon the enemy, to attack him in his position; then returning, lay siege to some important place, seize his magazines or depôts, and establish his line of operations. At others, he must open the campaign with the siege of some very important place; and then use it as a *place of arms*, to carry forward his operations, &c.

Defensive war.

If a general remain within his own frontier and there await the enemy, to repulse and prevent him from penetrating into his country, he is said to wage a *defensive war*. The conduct of this species of war is the reverse of the preceding; and though less dazzling, is not less glorious to the general who, like Fabius, knows how to direct it with superior talents and unshaken constancy. Its object is to protect a frontier and await a favourable moment to assume the offensive. Consequently he must avoid battles, arrest the progress of the enemy by seizing strong positions, cutting his communications, and acting and hovering constantly upon his flanks, &c. Finally, by bold and unexpected strokes he must raise the siege of places, and dismay the enemy. There are perhaps more talents and real courage required in defensive war, than in a war of

offence; it demands exhaustless patience and unyielding courage. The troops must be accustomed to daily combats in which they should always come off with advantage, be ever ready to fight or retreat, and rapidly adopt according to circumstances one or other of these alternatives.

Examples of offensive and defensive war.

Without seeking examples in remote ages, let us contemplate the operations of the French army during the last war; they afford the most instructive lessons in offensive and defensive war. At the opening of the campaign in 1792, the army of the North, acting on the offensive, entered Belgium, taking up its line of operations from the fortress of Lille. The enemy's army attacks and routs the French, which is compelled to resume the defensive on its own frontiers.

The army of the North in 1792, on the offensive.

The army of Champagne on the defensive in 1793

The Prussian army arrives and penetrates through the frontiers of Champagne, carries a fortress, and attacks the camp of *La Lune*. General Kellerman sustains the attack, arrests the progress of the enemy, and astonishes him by a most obstinate defence; then retires upon the grand army, which on the *active defence*, throws itself upon the enemy's flank, and with its own communications well covered, operates against those of the enemy and menaces his line of operations. The hostile army can advance no farther; the want of provisions and the ravages of disease, speedily oblige it to retrograde; the French army then assumes the offensive.

The army of the North on the offensive from 1792 to 1793.

The northern army again moves offensively, enters Belgium, wins the battle of Gemappe, carries many strong places, and during the winter has military occupation of the whole country. Meantime the enemy recovers from his terror, and secretly making every effort to repair his losses, opens the new campaign by offensive operations. The French army retires in all quarters, and regaining its own frontier assumes the defensive under the cannon of Lille and Valenciennes.

Let us take an example on another frontier.

The army of Italy on the defensive in 1796:

At the opening of the campaign of 1796, the army of Italy was standing on the defensive on the summits of the Appennines, from Savonna to Montenotte; its force was 50,000 men, but in want of every thing; and it beheld the plains of Italy in the military occupation of an enemy 150,000 strong, who denied them all hopes of being able to penetrate into those fertile countries. But what cannot genius, seconded by valour, effect! Another Hannibal rouses and inflames the French forces; they

Assumes the offensive.

precipitate themselves with the fury of a torrent from the mountain tops, and overthrowing every obstacle, descend into the plains. This active and severe campaign, maintained throughout the 11 months of its duration the same character, and ended in the entire conquest of Italy.

Army of Italy on the defensive in 1799.

During the absence of the conqueror of Italy, the war is rekindled. The campaign of 1799 is opened by the offensive operations of the combined armies of Austria and Russia; the French standing on the defensive. The contest lasts more than a year, during which the enemy make great progress. Mantua is taken, and the principal French positions are forced; the enemy penetrate into the heart of the country; and at the opening of the campaign of 1800, the enemy's advanced posts are on the frontiers of the maritime Alps. At this crisis, Napoleon returns to France, and is made first magistrate of the nation. His first care is to lead back the Italian army into the path of glory. A new army is formed, which he commands in person; he crosses the Alps, and descending into the plains, marches directly against the centre of the enemy's line of operations. The enemy instantly feels the influence of this movement and position of Napoleon, and before he can take any precautions, sees himself under the necessity of abiding the hazard of battle. The two armies meet in the plains of Marengo; the onset is begun; victory is long doubtful; Desaix devotes his life to his country; but science and courage triumph over every obstacle, and victory declares in favour of the French army, which assumes and maintains the offensive until peace is concluded.

The army of Italy partly on the offensive, in 1800.

59. The *habitual attitude* of an army operating on a frontier, offensively or defensively, is *that of defence*. Indeed any army, however powerful, may be surprised and attacked in its camps or positions by a weak but enterprising corps commanded by a general who makes up for deficiency of numbers by talents, valour, and devotion. Both ancient and modern history, and our own times, exhibit many instances of such attacks.

59 The habitual attitude of an army, in either offensive or defensive war.

Consequently a General, in taking up his positions, should select such as comport with his ulterior designs; provided they possess certain requisites for defence that we will point out. This was the reason that the Romans always fortified their

Consequence, respecting the choice of positions.

camps; and accordingly it was very rare for them to be surprised in their positions.

60. General disposition of an army upon a frontier; positions; lines of operations, &c.

60. An army operating upon a frontier, whether offensively or defensively, does not display itself so as to occupy all the points. The absurdity of such a disposition is obvious; its forces would be so scattered and so weak at all points, that the enemy could at pleasure break its line, and reversing all the unconnected parts, vanquish them without resistance.

An army should on the contrary concentrate in regulated masses on well chosen positions fronting the enemy, and affording room for the display of the order of battle in case of attack. From this position they watch the movements of the enemy, and act accordingly. Frequently, instead of occupying only one position, the army occupies two, and even three; but then there is the most immediate relation established between the detached, and the central positions; so that all the corps may mutually support and protect each other, and unite in one single order of battle in the least possible time.

Definition of position.

By *military position*, is meant the ground that an army may occupy upon a frontier, and on which the troops may encamp and fight, or thence march to battle. Thus the general disposition of an army on a frontier, consists in occupying one or many posts connected together, and in which it is proposed to encamp and fight, or from which the lines of march to attack the enemy are taken up.

Properties of positions.

Military positions should have general and peculiar qualities, in relation to determined objects; and when they do not possess these properties from nature, they must be created by art. As the *habitual* attitude of an army is *defensive*, its position, even for the moment, should likewise be defensive. From this consideration is derived the general properties; 1st, the length of the line of defence should be proportioned to the number of troops that are to defend the position; 2d, the flanks should be covered by natural or artificial obstacles, so that the enemy cannot attack the wings or rear of the order of battle (40); 3d, the interior of the field of battle should be free, and allow room for the manœuvres of all arms; and the debouchès in rear should provide an easy and secure retreat in case the position is forced; 4th, this position should be chosen with such judgment, that the enemy cannot penetrate at any other point without running the risk of being taken in flank and beaten by a

(See art. 40)

very inferior army. These properties should exist in a greater or less degree, according as the army is on the offensive or defensive.

If the army be on the offensive, and the war is very active, positions are only momentary, and their flanks and rear are secured as well as possible; the chief objects of attention are the debouchès and defiles, by which it is intended to march upon the enemy. If however the positions are covering and defensive, not only the flanks and rear must be secured with great care, but the front of attack also must be covered by natural or artificial obstacles; and the roads or debouchès to it, should be few and difficult.

Necessity of supporting the flanks of a position by natural or artificial obstacles, or by posting troops.

Positions being only the ground on which the order of battle is displayed, all the rules that we have previously laid down (40), are here susceptible of direct and general application. Hence it is, that the flanks of positions should rest upon obstacles difficult to be surmounted, and rendering attacks on these weak points almost impracticable and inefficient. When both nature and art are inadequate to secure the flanks of a position, they must be remedied by dispositions of troops, as has been well observed by the judicious Folard.

Natural and artificial obstacles.

The obstacles afforded by nature are abundantly scattered over the surface of the earth; they are described or represented in topography, and consist of water courses of all kinds, lakes, morasses, ravines, woods, slopes and declivities, hollow ways, villages, &c.

Those provided by art, are but modifications of the former, depending upon the application of the art of fortification by the engineers and artillery.

Camps on military positions.

When the general of an army has reconnoitred a position and ordered its occupation, the general officer who is chief of the staff, after providing himself with a draught of it extracted from the general and particular topography, marches to the position with a heavy detachment of light troops, supported by a division of light artillery. He reconnoitres it in the greatest detail and minuteness, and determines the front and extent of the colour line of the camp, or several camps that are to form the general encampment. He takes for rule the principles we have laid down (53), and deduces the composition of the front of the colour line from that of the line of battle, be it simple or complex, regular or irregular. He must not forget that each

(See art. 53)

arm should occupy ground adapted to its nature; that the health of the troops must be preserved; and that they should possess the facilities of procuring wood and water, &c.

Line of operations: its selection and importance in offensive or defensive war.

When the general commanding an army assumes the offensive, he moves from certain fixed points to penetrate the hostile frontier and enter the enemy's country. This direction given to the army, is what is called the line of operations. At its base or point of departure, are placed the depôts and magazines formed to supply the daily wants of the army. These magazines are in fortresses, or in towns hastily fortified, and comprise munitions of war, provisions, the divisions of artillery of reserve, the battering train, the pontons and their equipments, the companies of miners, the hospitals, &c. If the army were to carry in its train these immense materials and establishments, their preservation would be almost impossible, and marches would be so difficult, that victory could be only of momentary duration. Therefore depôts are formed in secure places in the rear, and the wants of the army are thence supplied by convoys and easy communications along the line of operations: these communications are besides of great importance to secure a retreat in case of disaster. In the present case, of an army on the offensive, the line of operations is protracted in proportion to the advance of the army into the enemy's country, and is often from 10 to 30 myriamètres (20 to 60 leagues) long.

Communications established in rear for convoys, and to secure a retreat.

When the general commanding an army stands merely upon the defensive, the line of operations is necessarily very short, and does not extend more than 4 myriamètres (8 leagues) beyond the places of depôt. The mere definition of the line of operations, shows not only its absolute necessity in the present mode of warfare, but also the importance that it be skilfully selected and established according to its topographical position, its extent, and the means that the enemy may have of operating upon it by flying corps, which striking dismay along the communications, may capture and carry off all the convoys.

In defensive warfare, the line of operations is easily selected and secured, because it is very short; the fortresses and a few redoubts on the lines of communication, are here adequate. But in offensive war, where the operations are carried to a great distance, the selection of the line of operations becomes very critical, both as to its direction and establishment: 1st, it must be the shortest that can be drawn, provided the communica-

tions are convenient and good; 2d, care must be taken that it does not present a flank to districts occupied by the enemy, and from which he may debouche; 3d, at proper distances it must be covered by points of support, such as intrenched camps, fortified posts and villages. small forts, redoubts, &c.; so that the convoys shall be constantly under protection, and move in security without danger of capture or surprise.

Intermediate intrenched camps, across the line of operations.

When the line of operations is greatly protracted, it becomes prudent, and often indispensable, to establish one or two intrenched camps placed nearly across the line of operations, and on the strongest and best selected intermediate positions for covering a retreat, if it should become necessary. With these points of support, a retreat is subject to much fewer inconveniences and dangers, and is often only a temporary retrograde to the first intrenched camp.

Remark.

In this respect the greatest faults were committed in the last war. Frequently, the French armies operating on the extremes of long lines of operations, could not maintain themselves for want of protection in the rear; and their retreats, though glorious and brilliant, could only have been effected amid such difficulties and these obstacles surmounted, by the greatest valour and devotion in the troops and talents of the Generals. So true it is, that the weakness of an army must be remedied and protected by art. If General Custine, when carrying his operations from Mayence into the Hundsruck, had fortified some post on the heights of Altzey, his communications with Mayence would not have been cut, and all the disasters that were produced by this neglect, would have been averted.

Examples.

If Prince Eugene in 1712 had not given to his line of operations a false direction which presented its flank to the army of Marshal Villars, the latter by forcing the single intrenched village of Denain, would not have repaired all the losses of the campaign and saved Landrecies.

The surest means of victory, and at the least loss, is to act upon the enemy's lines of operation and communication, by rapid, vigorous, and even daring strokes. It was by following this maxim, and favoured by a very broken country, the advantages of which he understood, that Napoleon anticipated and achieved those splendid feats that have immortalized the campaigns of 1796 and 97.

Consequence.

Theory and experience both concur in this great truth—that

a single corps d'armèe in a situation enabling it to act on the enemy's line of operations, can keep in check a mighty army and frustrate the most extensive plans of offensive war. But this corps must have at its head a Fabius, a Turenne, or a Luxembourg.

61. Choice of camps and positions.

61. The choice of camps and positions requires great judgment, and a habit of viewing a country under all the relations of attack and defence. Every position must fulfil the end proposed, and possess all the properties that this requires ; these we have already laid down. Without the elements of topography and reconnaissances, it would be very difficult to judge of the value or importance of positions, and the direction of the line of operations, or to combine the movements of an army. The selection of positions, and combining movements with time, are the fruits of the *coup d'œil* improved by the practice and experience of war. Of all the Generals of the staff who have written and laid down rules on this most important part of war, General Bourcet, of the engineers, is the most distinguished. He never has been excelled in topography and in the science of marches and positions. He possessed in an eminent degree the *coup d'œil* in the choice of positions; and all officers who would make their way to fame by serving in the staff, should study in nature and in books the sciences and knowledge connected with this talent, without which it is impossible to become an able General.

The coup d'œil. (See Chap. I, art. 2.)

62. Disposition of fixed batteries on defen-ive positions : epaulments : and communications in rear of the batteries.

62. As soon as an army seizes a position and the order of battle is nearly determined, the chiefs of artillery and engineers separately reconnoitre it in all its relations with their two arms. The latter causes all the works of fortification to be executed, as we will hereafter detail ; and the former determines the positions of the fixed batteries that are to co-operate in the defence. As all the ground in front, on which the enemy must form his columns of attack, is known, and the direction of the attack anticipated, most of the batteries are fixed. There is an art in disposing them that should be displayed by the *coup d'œil* of the artillery officer. These batteries should be very commanding and cross their fire towards the points whence the enemy is expected to debouche ; they should, without being too much exposed themselves, take the hostile columns in flank. They must not embarrass the movements of the troops, &c. nor be too much elevated ; they should be situated in front of the field

of battle on gentle slopes, in order to the most effective razant and ricochet fires. Batteries of position are covered by epaulments, from behind which they fire *in barbette*. When they are advanced in front of the field of battle, care must be taken to connect them with the rear by convenient communications; so that the pieces may be quickly withdrawn the moment that the firing restrains or impedes the movements of the troops. Batteries of position are generally composed of 8 and 12 pounders.

The intrinsic and relative strength or value of positions.

Every position, exclusive of its *intrinsic strength*, which depends upon the strength of the fronts of attack, has also a *relative strength*, depending on the situation of the enemy. A position is strong and fulfils its object, when the enemy is not in a situation to act upon its flanks and communications; but it becomes weak and bad, the moment that the enemy has this power. The position must then be abandoned for another better covered, and not exposed to his operations. The *positive strength* or value of a position, is deduced from these two considerations.

63. Particular instances of defensive positions.

63. The better to illustrate these general precepts, we will cite a few examples of defensive positions whose properties and positive values have changed with the situation of the enemy's army. We will select them from the campaign of 1793, the operations of which are little known, because the turmoil of the revolution then extended even to the armies; and the service of the staff and engineers was at that time so badly organized, that no memoirs were compiled, nor plans taken to bring them under the notice of the government. The topographical and reconnoitring departments, we may say, had no existence; the few skilful and able officers that were to be found in the armies, were overwhelmed by the burdens of daily duty.

Defensive position of the army of the Rhine in front of the Naha, in 1793.

In the month of Ventose, 1793, the army of the Rhine, about 24,000 strong, marched from Mayence into the Hundsruck on the offensive. After a few battles, they resume the defensive and establish themselves in front of the Naha between Bingen and Creutznach, on the position of Hungergrivervoof between the two small rivers Guilbach and Grevebach. The camp was upon the summit of the mountain; and as the ground gently declined towards the enemy, the front of the line was covered by a chain of batteries crossing their fires upon the debouchés of the defiles whence the enemy's columns must issue to

attack the camp. The enemy did not think of attacking the front of the centre, but turned his attention to the right wing, and after a severe contest carried the heights of Bingen, and even Bingen itself; then taking the centre which had the river in its rear, in flank, compelled the French to retreat by their left on Bingen and the heights of Altzey*.

Army of the North in defensive position at the camp of Cesar, under Cambrai, in 1793. (See PLATE VII.)

We will now turn to the army of the North, to contemplate another very remarkable instance in defensive positions.

The army of the north after having evacuated Belgium in

* We suspect that there is some mistake in the account of this battle; but for want of detailed maps, are unable to correct it. The left must have been at Bingen, and the right at Creutznach, because the Naha was in rear. The left being forced, (and not the right as the text reads), and Bingen carried, the army retreated on Altzey, which is off on the right some leagues up the Rhine. This must have been the course of events; unless there were two Bingens, one on each flank; the general maps afford no authority for so believing. It is in general contrary to the rules of the science to fight with a river at your back; because if defeated, destruction is inevitable if your enemy understand his trade. The fall of Napoleon may be directly traced to a violation of this rule at Leipsick, in 1813, where the desertion of the Saxons and the arrival of Benningsen with the Russian army of reserve having produced defeat and rendered a retreat necessary, it was almost impossible to effect it with the Elster and Saal at his back, and only one bridge to debouche by. The retreat became a rout; the city of Leipsick was carried by assault; and the French troops, driven towards the bridge, were partly cut to pieces, and partly thrown into the Elster. The loss was prodigious, and had a decisive influence on the subsequent operations between Paris and the Rhine.

We need not look abroad for an example of this kind. Had the British instantly followed up the victory of the 27th August, 1776, and not waited 'till the next day to secure their prey, the American army on Long Island must have been totally captured or destroyed. Not a man could have escaped. General Washington availed himself of the night and respite afforded him by the incapacity of the enemy. The retreat across such a river, and in so short a time, *and in boats*, shows what immense efforts must have been made—efforts which perhaps nothing but a conviction of certain destruction on the morrow could have accomplished. In the subsequent campaigns we find Washington carefully avoiding battle with rivers at his back—witness his operations on the Hackensack and Passaic, &c. If an army, in defending New-York, fight and lose a battle on Long Island, and have no regular fortress on Brooklyn heights or in their rear to retreat into, that army will be utterly captured or destroyed. And it is on Long Island that New-York must be fought for.

TRANSLATOR.

germinal 1793, was assailed by new disasters and abandoned by its General, who went over to the enemy: his successor, the gallant Dampierre, was soon after killed in reconnoitring. The army then retired to the position of Famars, under the cannon of Valenciennes, and was busily employed fortifying the camp and covering its front with batteries, when the combined armies of England and Austria, commanded by the Duke of York and Prince of Cobourg, impetuously attacked the camp of Famars, and overthrew the French army under the walls of Bouchain and Cambray.

An engineer having pointed out the position of the camp of Cæsar, the wrecks of the army were collected, and the unfortunate Custine applied himself to its re-organization. This position, as is shown in Plate VII, is on the heights between the fork formed by the Scheldt and the Censée, whose banks are very marshy. The front of the position forms a salient angle, covered by Bouchain and the marshes of the Censée. The left was secured by the course of the Censée, by a flanking corps from the left upon the heights of Oisy, and by the defences behind the canal from D'Arley to Douay. The right returned upon Cambray along the Scheldt; its front was covered by a chain of batteries of position, defending the approaches of the posts on the Scheldt by long and ricochet fires. Above Cambray, and in the villages bordering the left bank of the Scheldt up to Crèvecoeur, the cavalry were cantoned; and at the first signal were to debouche by the bridges over the Scheldt into the plain between Solesme and Cambray.

A detached corps of 7000 men was stationed at the camp of Hecq on the left border of the Mormal forest, to cover Landrecies and support the garrison of Quesnoy: this corps was too weak, and being distant about 5 myriamètres (10 leagues), could not co-operate in the defence of Cæsar's camp; and to execute the General's plan of succouring Valenciennes, its force should have been 15 to 20,000 men.

So long as the enemy were engaged in the siege of Valenciennes, the position of Cæsar's camp fulfilled its object, by reason of its intrinsic strength. But the moment that fortress yielded, the whole aspect of affairs changed, and solely by the new situations in which the belligerent armies found themselves. The enemy resume offensive operations, which the siege of Valenciennes had interrupted; and taking advantage of the

great opening between Landrecies and Cambray, move forward with an immense cavalry sustained by horse artillery; they force all the passes of the Scheldt, and reversing the French army, cut almost all its communications; leaving it only the alternative of fighting on unfavourable ground, or retreating to another position. The latter was adopted. The army effected its retreat behind the Scarpe, and took post at Gaverelle, between Douay and Arras, having Lille in its rear; and by this judicious movement placed itself on the flank of the enemy's line of operations.

64. Necessity and advantages of van guards.

64. An army operating upon a frontier has always its front covered by a heavy detachment called the *van guard*, to prevent surprises in its marches and camps. This corps, formed according to the service it is to perform, keeps as near the enemy's army as possible, and observes all its movements. Frequently a van guard is insufficient; and if the General be under any fears for his flanks, he detaches flanking corps to cover them. These flanking corps are used in marches especially. By these prudent measures, inquietude is a stranger to the camp, and the army sleeps in security.

Flank guards.

The van guard of an army should be commanded by a General perfectly acquainted with the war of posts, and the service of light troops; he should be active and enterprising, full of stratagems, and inventive of means to deceive the enemy and discover their intentions and situation. All the characteristics of a man born to command armies, should be possessed and displayed on all occasions by the General of the van guard.

Strength and composition of the van guard; and its principal duties.

The strength of the van guard is generally one-tenth the force of the army; it is entirely composed of light troops, with one or two divisions of horse artillery. The duties of the van guard enable it to take the most distinguished part in all operations and attacks to which the army is exposed. If the enemy's army move to attack, the van guard sustains his first efforts, and then retiring slowly upon the main body, affords time to form the dispositions of the order of battle or march to meet or await the enemy, to change position, or retreat. If on the contrary the army attack, the van guard covers and conceals the dispositions from the enemy; then drives in or overthrows his out-posts, and stands ready to march in pursuit, harass him in his retreat, and complete the victory. In front marches, the van guard is half a day's march in advance of the army; it

scours the country to discover ambushes and enable the engineers, artillery, and staff officers to open roads and passes for the columns, and to construct bridges over creeks and rivers. The van guard is frequently supported by a corps of grenadiers. When the van guard has passed the position on which the army is to halt and occupy, or rest, it takes up another defensive and covering position for itself, which it fortifies on all sides, and seizes all the debouchés. In marches in retreat, the van guard redoubles its activity; and before the army moves off, makes false attacks to deceive the enemy. When it sees the camp struck and the army in retreat, the van guard then also retires; turning upon the enemy whenever he pursues too warmly

65 The principal operations that take place in the course of a campaign. (See Puysègur, Turpin, de Crissé, Folard, Feuquières, and others.)

65. The principal operations executed by an army in the course of a campaign, are; 1st, strong or forced reconnaissances, and all the dispositions relating to orders of march in attack or retreat: 2d, the passage of rivers in attack or retreat: 3d, the attack and defence of positions: 4th, foraging: 5th, the attack and defence of convoys: 6th, the attack and defence of intrenched camps and posts; and 7th, the attack and defence of fortresses. To treat each of these subjects fully and at large, it would be necessary to write a complete treatise on war; and we have already observed that such was not the plan and limits marked out for us. We refer the reader to the excellent works extant on these subjects, restricting ourselves to giving a simple exposition of those subjects which more particularly deserve the attention of students and officers who are desirous of directing their studies to them.

Forced reconnaissances.

Forced reconnaissances are; 1st, to reconnoitre in detail a district of country occupied by the enemy's posts. To effect this, the engineer and staff officers are sustained by detachments of light cavalry, and also of light infantry, if posts are expected to be attacked. Dragoons, as they are at present armed, are admirably calculated for this service, for they can if required do the duty of infantry; they should be accompanied by some hussars. 2d, to reconnoitre the whole extent of positions occupied by the enemy. Most frequently this latter reconnaissance is made by the General in person. He drives in all the enemy's outposts, and penetrates the artificial screen that they form about themselves, and thus ascertains their dispositions and order of battle. Here it is that the coup d'œil of the General is exercised, and decides the fate of battles. But however admirable it may be, it

would be impossible for the General to judge of the depth of the enemy, and his dispositions in the rear and on the flanks: to discover these, he must ascend some lofty elevation, such as a steeple, a tree, &c. Turenne caused an old soldier to climb a tree to discover the movements and dispositions of Montècuculi. In the attack on Bambeck in the evening preceding the eve of the battle of Hondscoote, the Colonel Adjutant Coquebert de Monbret climbed a very high tree to ascertain the enemy's positions. The use of a balloon quickly raised and hovering over the enemy, is the best and most infallible mode yet invented of discovering his dispositions. 3d. The investment of a fortress is no more than a grand and forced reconnaissance.

Use of balloons in reconnoitring positions or orders of battle.

The general object of a march is to transport the army from one position to another, or upon the enemy's army to attack him. We have said (Chap. V. art. 35) that the march of troops is the most important branch of minute tactics; and we may here say, that the march of armies is that branch of grand tactics on which the success of operations most depends If Turenne had not combined with the greatest precision the march of his columns, so as to attack simultaneously all the quarters of the enemy cantoned in Alsace, would he have achieved such splendid results? If Napoleon had not profoundly calculated his marches, would he have conquered Italy with a rapidity that may be likened to a torrent, which though apparently irregular in its course, is guided by the irresistible laws of gravitation? Had Moreau not given to his orders of march and to all his movements that regularity and precision required by the nature of the country and the war, would he have been able to have effected those rapid formations of orders of battle that carried him victoriously over all the positions that covered the Austrian capital? Turenne, Montècuculi, Luxembourg, Vendome, and Eugene, &c. all attached the utmost importance to marches. Luxembourg had in this respect rare talents; in the day of battle his movements were directed with a dexterity and address frequently decisive of victory.

Marches in general: orders of march.

Plans of marches are founded upon the topography and reconnaissances. The directions in which the columns are to move, are traced upon the map; and by knowing the nature of the obstacles to be overcome, the time may be calculated that each column will require to arrive on its destination. The engineers and staff officers, preceded by the van guard that scours

Topography in relation to marches.

the country and watches the safety of the march, reconnoitre minutely the route of each column, clear obstacles, erect the necessary bridges, fill up ravines, cut through woods, and mark out the direction that it may be followed even at night. Numberless operations have failed by columns losing their way in the night and taking false directions.

Order of march, and number of columns.

Orders of march are the consequence of the impossibility of marching in order of battle, and of the necessity of forming columns that separately move to the designated position by the route indicated in the plan of march. It is obvious, that the more numerous the columns, the sooner the army will reach and occupy the new position in force; supposing that they do not arrive all at the same time. If therefore a country be perfectly open and unbroken, this order may be adopted, and the several arms divided into many columns; but if the country be wooded and broken, this is impracticable; the number of columns will therefore be determined by the communications indicated in the topography and reconnaissances.

Order of march: the arrangement of the columns of the different arms.

The order of march strictly means the disposition of the columns of the different arms and of baggage. When there are no fears of an attack from the enemy, the nature of the communications, and the order of encampment on the new position, determine the disposition of the columns; it should be such, that they will arrive on the new positions to be occupied, in the speediest, most convenient, and most direct manner possible.

Order of march in plain countries in presence of the enemy, whose front is nearly parallel to the new position.

But when in presence of the enemy and marching almost directly against his front, if the country be open, little broken, and easy, the order of march must be a moving order of battle, capable of being quickly displayed in case the enemy advanced to battle before the troops have attained the new position. Accordingly, if we suppose the order of battle formed in the common manner, the van guard precedes the army by half a day's march, or $1\frac{1}{2}$ myriamètre (3 leagues). The light infantry and light cavalry, on the right and left, cover the flanks of the march. Two or three columns of heavy cavalry form each flank, with the infantry of the line in the centre between them in 3, 5, or 7 columns. Next *in rear* and following the centre of the army, comes the artillery and park, guarded by the reserve composed of grenadiers and dragoons. On the supposition of a different order of battle, for instance, such as the

3d order described in art. 39, the arrangement of the columns would be different. The whole front of the march would then be composed of columns of infantry, more numerous and with larger intervals; and each column of infantry would be followed by a column of heavy cavalry, &c.

The order of march in a broken, woody, and mountain country.

If the war be in a woody country, intersected and broken, the order of march becomes more complicated, and requires the greatest precautions. The army is then obliged to use the communications that are at the foot of mountains and bottoms of valleys, and which lead through vales and gorges. In this case, which is susceptible of infinite varieties, the flankers on the right and left are composed of light infantry only, who keep the most elevated ridges and climb over all obstacles. The infantry of the line march in columns on the sides of the mountains, always ready to seize the adjacent and commanding heights. The cavalry, artillery, and baggage, follow the communications along the foot of the mountains and bottoms of valleys and gorges.

By this disposition, depending upon the ground, if the enemy present himself upon the front of the march, the order of battle is instantly formed, and each arm finds itself on its proper ground.

Order of march when the enemy is on the flank.

When the direction of the march presents one of its flanks to the enemy, the movement becomes critical, and requires great talents in the General. Turenne frequently executed marches of this kind, and succeeded by wise precautions. It is proper to observe, that these movements are not so dangerous when the country is broken and intersected, as in a plain country; because it is more easy to conceal the movement from the enemy, and repulse him by taking advantage of the natural obstacles. The order of march in the case under consideration, should be an actual order of battle marching by a flank, with the right or left in front, according to the position of the enemy, and covering the columns of cavalry, artillery, and baggage. Two corps of grenadiers, with some horse artillery, sustain the head and rear of the march. The van guard is almost stationary; it occupies good positions, and watches the movements of the enemy*.

* Marches should always if possible be executed by the flank—that is, the army should march by the flank of its two or three lines, the lines pre-

Marches in retreat, in presence of the enemy. (See Xenophon, Folard, Feuquière, Puységur, Turpin, the Encyclopædia, &c. and works on the operations of modern war.)

The order of march in retreat, before an enterprising enemy acting offensively, admits many combinations, and is one of the most complicated operations of war, and absolutely requires the aid of the science of fortification; giving rise to continual combats, offensive and defensive. Sometimes we must await in one position and repulse the whole force and power of the enemy, before we take up another. Sometimes we must return upon the enemy and give battle, to push him back and keep him in such dread as to prevent his detaching separate corps to act upon the flanks and rear of the retreat. At others we must make large detachments to repulse the enemy acting upon the communications of the flanks and rear. Finally, we must provide for the safety of the baggage, equipage, park, &c. and for the subsistence of our army.

The order of march in this case, should be a moving order of battle, covered by a strong rear guard and flanking corps; and must always be founded on an order of battle adapted to the position on which the troops are to rest and refresh themselves, in order that it may be displayed rapidly and without useless movements. The operations of a retreat require on the

serving their distances in rear of each other, and being in platoons at entire distance. The advantage of this order is so superior, its mechanism so simple, that we are astonished to find it totally omitted by Guibert; although this was the constant order of the Great Frederick, whose tactics this ingenious author appears to have totally mistaken. Arrived on the field of battle, the lines are formed in a moment by a mere conversion of platoons to the right or left; and may instantly advance to bear down the flank or centre of the enemy, before they can change front or re-enforce the assailed flank. This was the order of the Prussians at Prague, and Kollin, and at Rosbach, Leuthen and Zorndorff, where they smote with dismay and death a thrice superior foe. Where a march must be executed immediately to the front, it should be by columns formed on the principle of the *column of attack*, and with only the deployement intervals between them; that is, the right wing should form column on the left, and the left wing form column on the right. The columns will thus be near each other, will keep dressed, and will display—the right to the right—and the left to the left. Guibert's plan of marching by columns of divisions and displaying these deep masses, never could be executed in the presence of a Frederick, a Napoleon, or a Turenne. The columns would be taken in head and on both flanks, before they could unfold their complicated depths. The front march that we have described, was that of the Prussian General Lehwald at Jægerndorff, in 1757.—See *Jomini, Part I. Guibert, on Marches.* TRANSLATOR.

part of the General the most perfect knowledge of the country through which he is to move, and that he constantly keep in view the powers of artillery and fortification; his army must be perfectly disciplined, and he must possess its entire confidence. The glory that a General acquires by a retreat, rendered necessary by circumstances and ably conducted, is founded on a display of the greatest talents in all branches of war, seconded by unshaken courage. We cite with the highest eulogium for the consideration of the young officer, and recommend to his careful study, the retreats of the great Generals of antiquity and of modern times; beginning with the celebrated retreat of the Ten Thousand, which has conferred immortality upon Xenophon. Perhaps in the military annals of the moderns, he may find similar achievements that willequally excite the astonishment of posterity, and secure to the Generals who conducted them, imperishable glory and renown. What vast conceptions and grand combinations are required by the immense extent of country covered by the mighty armies of the moderns, of such numerical forces and various weapons!

Passages of rivers on the offensive, and in retreats.

The operations of the passage of rivers and streams, when the enemy is in a situation to oppose the manœuvres and establishment of bridges, require great daring and ability in the General and officers. These passages are effected either by main force, or by stratagem and surprise. As the arms of artillery and engineering influence greatly the success of these operations, we will in the Second Part, on Field Fortification, treat this subject more fully.

Mode of attacking a position defended by an army.

When an army marches offensively on its line of operations to attain the enemy, it attacks him in his positions, to drive him from them and possess itself of the country. An army even on the defensive sometimes attacks an enemy in his positions; this operation takes place whenever the enemy divides himself into many corps to undertake a siege, or for any other purpose. The army on the defensive then attacks his separate positions, to force him to abandon his chief object. We frequently see a weak army repeatedly beat a more numerous enemy, and finally assume the offensive. In 1793 the army of the north was thus fortunate, when, after the capture of Valenciennes, the combined army separated into two corps, taking up two diverging lines of operations, the angle of which included

the French army. The latter was thus enabled to attack and beat the English before Dunkirk, and then to turn upon the Austrians and vanquish them under the walls of Maubeuge, and thus assume the offensive*.

There are two methods of driving an army from its position. By an attack by main force, compelling the enemy to retreat; or by skill and stratagem, acting upon his flanks, communications and line of operations. The two methods are combined by modern Generals, who in this respect take for models Turenne, Luxembourg, Frederick, and other great captains.

The reconnoitring of a position that is to be attacked.

The success of an attack very frequently depends upon the minute reconnaissance that the General makes of the position, to discover its strong and weak points, the dispositions and arrangements of the troops, and to form the clearest idea of the site. To this effect imaginary mathematical lines are drawn, cut by vertical planes, on which the eye traces the profiles or sections of the ground. These lines are; 1st, the horizontal, joining the two wings, and to which all the intermediate points

* Here we have an exemplification of *interior* and *exterior* lines of operation, and the result of choosing either. It is a fundamental maxim of war, to choose but one line of operation, if possible. But if circumstances and the measures of the enemy force you to a double line of operation, let your lines be interior to his double line; occupying the centre of the chord, you can form in mass and precipitate yourself upon and destroy in succession both of the hostile divisions.

In this case, the combined army was placed in a situation where its defeat was inevitable. The allies divided their forces, and occupied the two extremes of the chord; leaving the French in mass upon the centre of the arc. What else could have resulted from such ignorance and incapacity, than the destruction of the two isolated corps?

The best defensive positions will not prevent the invasion of a country. It is by manœuvres—not by positions, that a country must be defended: this is another proof—*That the use of masses upon decisive points, alone constitutes good combinations; and this use of masses should be independent of any localities.*—See *Jomini*, Part I, p. 123.

There are very few positions, however celebrated for strength, that have not been forced; for if a position cannot be forced in front, it may be in flank or rear, or it may be turned and rendered nugatory. There is another disadvantage inherent in positions; they weaken the courage and confidence of the defendants, whilst they confine and straiten them, and prevent offensive returns against even a beaten enemy.

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are referred by ordinates traced by sight; this line is protracted about 1200 mètres (1340 yards) beyond the flanks: 2d, three other lines or axes perpendicular to the first, and cutting the centres of the two wings and centre or main body.

By profiles constructed on these lines, we find the principal properties of the position in relation to its attack and defence. The profile of the front line will show whether there is beyond the flanks any commanding heights that may be seized, and whence the position may be taken in flank by strong fixed batteries. The profiles on the axes will show the best direction that can be given to the columns to break the enemy's front.

Direct and oblique attacks by main force.

If the attacking army assault the front of the position in such a manner that all parts of the line come at once into action, it is then said that the attack is *direct and general.* But if this army refuse the greatest part of its line, whilst the other part, sustained and reinforced by select corps, breaks the enemy and is followed by the rest of the order of battle marching obliquely to take in flank and reverse the disunited portions of the hostile army; the attack is in this case said to be *oblique.* This species of attack is the most skilful, and wins the victory with the least loss; but it should be conceived at the instant, and executed with the greatest vigour and rapidity. It is only men of genius who can conceive and execute such attacks.

Attacks by stratagem and skill.

The attack by stratagem and ingenuity, is when the enemy is compelled to quit his position without the army hazarding a general battle. This method should be ever preferred when circumstances permit; it is the resource of an army, small in numbers, but active, enterprising and very light. To execute this kind of attack, we must carry our forces upon the enemy's flank, slip into his rear, and cut his communications and line of operations. This manœuvre, if it succeed, will compel the enemy to retrograde or abandon the important enterprise in which he has employed a portion of his troops.

Methods of attacking, direct, or partially, intrenched positions.

The students and young officers can as yet form no exact idea of the methods of forcing one or many fronts of attack of an intrenched position. The site being supposed to have been modified by the art of fortification, remains yet undetermined; consequently a knowledge of the nature of the obstacles cannot be obtained by them by reconnaissances. It is only at the conclusion of the Second Part that they will understand this

matter. We will therefore for the present only say, that too many precautions cannot be taken to reconnoitre an intrenched position and discover its strong and weak points. The attack should be divided into two periods, the *distant*, and the *near* periods of attack. At the first, all the artillery of position is successively displayed within about 500 mètres (555 yards) to ruin the defences, and particularly to silence the fire of the intrenchments by giving the fire of the batteries the most advantageous direction, &c. After this preliminary combat of artillery has produced its effect, the sharp shooters (*tirailleurs*) cover all the space from the batteries to the intrenchments, and by their fire conceal from the enemy the dispositions for the second period of the attack, which must be decisive. These sharp shooters must advance to the very barbettes of the enemy, to fire at the artillery-men and into the works. Covered by these sharp shooters, the engineers are enabled to approach close to the intrenchments to reconnoitre them the better. After these preparatory measures, the columns of attack are put in motion; preceded by the sappers, and guided by the engineers, they penetrate the intrenchments, overleap all obstacles, and form in line in the interior of the position. The workmen attached to the engineers, quickly cut openings and form ascents for the passage of the artillery and cavalry, part of which pursues the enemy whilst the rest enter into line.

Defending intrenched positions.

The mode of defending an intrenched position, is deduced from the expected conduct of the attack, the nature of the site, the form of the works, their armament, &c. With these data the general plan of the defence is formed, and is modified in the moment of action according to the real attack. There are three periods to be distinguished in the defence. During *the first*, the artillery sustains the action and endeavours to dismount the enemy's pieces; and also fires on any masses of the enemy within reach. At the *second period*, all the fires, both of musketry and artillery, are opened on the attacking columns. And *at the last*, the fires are suspended, and the enemy is opposed with the sword and the bayonet. When it is perceived that the fires have checked and intimidated the enemy's columns, a sortie is frequently made to charge them with the sword and bayonet. We will resume this subject in the *Second Part*, when we have developed the nature and influence

of field fortification. All that we have said in relation to the attack and defence of intrenched positions, is equally applicable to that of posts.

The manœuvres of attack and defence relative to the operations called foraging and convoys, belong to minute tactics, and are not the province of this Treatise. The young officer who follows this course of study, must consult the best works on those branches, and especially *The Officer's Guide in the Field*, by M. de Cessac.

The operations of foraging and convoys. (See Turpin, de Crissé, the Encyclopædia *Le Guide des Officiers en Campagne*, &c.)

The military operations that the attack and defence of fortresses give rise to, are very complicated, and require on the part of the students and young officers, extensive and laborious studies. They become however easy, as respects the theory, by the aid of the mathematical and physical sciences and descriptive drawing.

The attack and defence of strong places.

The regular attack and defence of strong places will be treated in the Third Part, as necessary to the study of permanent fortification; for the present we will limit our observations to a few words on irregular attacks.

A town may be taken by surprise, when the troops to defend it are few, off their guard, or the fortifications have defects which authorize the attempt. Success depends upon secrecy, the discipline of the troops, and the daring courage of the commander.

Surprising strong places and posts. (See Folard, the Encyclopædia, & the Officer's Guide.)

The ancients frequently took towns by escalade; but such attempts rarely succeed in modern times, though history affords some memorable instances. The surprise of a place is more often effected by secret understandings with the citizens, than by any other means. The surprise of Cremona by Prince Eugene, of Mayence by Custine, and of Frankfort by Frederick, are remarkable examples. To compel places to surrender, the moderns produce conflagrations, and operate upon the fears of the besieged by employing a powerful and destructive artillery; but the defence of Lille and Mentz shows that these are of not much avail against a large city well defended.

A town is blockaded by surrounding it on all sides and cutting it off from all hopes of exterior succour; so that the garrison must surrender after consuming all their provisions. It was in this manner that Luxembourg, after being blockaded during the severest winter, was acquired by the French republic. A

The blockade of towns.

blockading army should take the utmost precautions both against the garrison and against enemies from without. Lines of countervallation and circumvallation must be drawn with great care, as we will show in the Third Part.

We will here conclude this general exposition of the principal operations of a campaign; but we will, in the Second Part, further discuss those in which the arms of artillery and engineering have particular influence.

CHAPTER X.

Examples and Illustration of several Military Events and Operations.

66. Reflections.

66. WE will conclude our reflections upon the science of war in general, by describing a few military events and operations that exhibit in a still stronger light the influence of artillery and fortification; and which will help to familiarize the young student and officer with the whole system of operations that are displayed, and connected by an infinity of combinations, in the course of a campaign. To treat this important subject in the most perfect and instructive manner, we should begin by describing and analyzing some very simple events of the several kinds and species of operations; thence ascend to those that are more complicated, to finally arrive at the complete system of operations in a plan of offensive and defensive war. But the nature of this work does not permit us to detail completely so extensive and difficult a subject; we must therefore restrict ourselves to a few illustrations extracted from modern military annals, and wait 'till the more advanced studies of the students and young officers enable them to conceive and analyze grand operations, of which the great Frederick gave the first examples; and which, by the greatest national impulses, were carried in the last war to a height of combination that the science of war had never before attained.

First example. Battle of Turckheim, under Colmar, won by Turenne, on the 5th January, 1675 (See the map of the Rhine.).

The battle of Turckheim, gained by Turenne over the Imperialists intrenched under Colmar, is a memorable instance of an intrenched position forced by skill, the result of a strong reconnaissance made by the French General in person.

After the battle of Mulhausen, the enemy, though superior in number, took up a defensive position under Colmar, along the arm of the Fecht. They were 38,000 strong, of which 18,000 were cavalry. The army of Turenne was only 34,000 men, of which 15,000 were cavalry. Turenne having advanced into the plain to reconnoitre the enemy, decided that it would be too dangerous to attack the front of the position; but remarking that the prolongation of the enemy's line on the

left, rested upon a commanding height that was not intrenched, nor even occupied, he displayed his first line on the enemy's front, whilst the second line with the artillery made a detour to the left, passed the Fecht, and took possession of the heights; and thus took the enemy's army in flank. This admirable manœuvre rendered useless the intrinsic strength of the front of the position, and compelled the enemy to retreat and abandon the field.

The reign of Louis XIV was an epoch illustrated by the glory and brilliancy of French genius of all orders, and produced such a multitude of military achievements, and so many great Generals, that it is not astonishing to find in their history many traits bearing the greatest resemblance and analogy to the battles in the last war.

Second example. Battle of Malplaquet, near Mons, 11th September, 1709 (See map of the environs of Mons, & PLATE VIII.)

The battle of Malplaquet deserves our attention on many accounts; it will show that indecision and an ill chosen position, may bring on the loss of a battle and the greatest disasters.

The description and analysis of the campaign of 1709, is an ample field of instruction; but its magnitude does not allow us to detail it; we will begin at the battle of Malplaquet.

Respective forces.

The French army, commanded by Marshal Villars, was nearly 100,000 strong, and was composed of 150 battalions and 300 squadrons. The allied army consisted of 120,000 men, divided into two armies; one of 64 battalions and 116 squadrons, commanded by Prince Eugene; and the other of 101 battalions and 154 squadrons under the Duke of Marlborough.

Both armies had a powerful artillery of about 60 to 80 pieces of position.

Preliminary details of movements of the enemy, from the 4th September, 1709.

The enemy after the siege of Tournai, which they had taken in sight of one of the largest armies, formed the project of taking Mons; and as the Chevalier Luxembourg occupied the lines of Trouille, the Prince of Hesse Cassel marched against them with a van guard of 60 squadrons and 4,000 infantry, and compelled Luxembourg to retreat. This hostile van guard took post with its right in the village of Quême, and its left resting upon Haute-Trouille: this movement cut the communications of the French with the town, and invested it.

Movements of the allies.

On the 4th September the enemy's army put itself in motion, leaving only one corps under Tournai; after occupying

some intermediate positions, the combined armies passed the Trouille on the 7th and 8th of September, and took post with their right commanded by the Duke of Savoy (Eugene) at Carignan, and their left under the Duke of Marlborough at Bettigny.

Arrival of Marshal Boufflers; resolution to give battle.

At this period Marshal de Boufflers arrived in the army to second Marshal Villars; the two Generals determined to give battle for the relief of Mons.

Movements of the French.

On the 6th of September the French army passed the Scheldt at Valenciennes, and encamped at Quévrain. On the 7th, the French pass the Honneau, and encamp with their right at Attiche, and their left at Montreuil. On the 9th, the army marches by its right towards the enemy, and is discovered at the moment it possesses itself of the villages of Tainières, Blangies, Malplaquet, and the opening of about 4000 mètres (4450 yards) between the wood of Sars and the wood of Lanière.

Prompt movements of Prince Eugene.

Prince Eugene seeing the French army marching upon him, resolved to anticipate them, and to arrest them in their march; he marches from Ciply to Blaregnies, which fronts the opening between the woods.

The nature of the ground.

It is proper to observe, that the ground declined towards the enemy, was waving, and intersected by ravines and rivulets running from the woods to the Trouille; so that it was ill fitted for the formation of an order of battle, as it was scarcely possible to display the troops upon it.

The enemy having reconnoitred the ground and found it unfavourable to him, and perceiving that the French did not hasten to gain the head of the opening in order to have this broken ground in their front, anticipated them by advancing the heads of his columns with orders to maintain their position through the night of the 9th to the 10th; moreover he strongly occupied a farm and small lofty wood that was in the opening. After thus disposing his centre, he extended his right along the wood of Sars, to outflank the French left; and supported his right on the wood of Lanière: in this situation he awaited a reinforcement of 30 battalions, momentarily expected from Tournai.

General dispositions of the enemy.

General dispositions of the French.

It is not known why Marshal Villars remained inactive; for instead of fighting, he employed himself in defensive measures, without endeavouring to seize the advantages offered by the ground at the first moment. He established his centre in front

of Malplaquet in the opening, which he caused to be intrenched. His left was thrown forward in front of a long strip of the wood of Sars, which advanced far into the plain: his right rested upon the wood of Lanière, extending a little into the forest.

Defects of this disposition.

This general disposition was full of defects: he had neglected to seize the farm and the small high wood in the centre, of which Prince Eugene possessed himself. The front was not sufficiently advanced: and the right wing did not extend far enough into the wood. But the most striking error was in the left wing, which was disposed in the worst manner, as the plan of the battle shows; for the enemy could turn it by the wood of Sars, behind which he had displayed his right.

It seems that on the evening of the 10th, the French General had an intention of changing his first dispositions; for he caused to be traced out and begun a second intrenchment in rear of the opening; but it was abandoned in the night.

The French order of battle.

The intrenched front of the opening, and the wings of the position, were occupied by the infantry; the artillery was distributed along the centre: there do not appear to have been established any flank batteries, crossing their fire on the front, and especially on the left wing.

The household troops were in battle array behind the front of the opening, with their right on Malplaquet, which village was covered by 7 or 8 battalions sustaining the right wing. Ten battalions and 30 squadrons were injudiciously displayed behind the border of the wood of Sars.

A second line, in rear of this wood and of Malplaquet, with infantry in the centre and cavalry on the wings, completed the order of battle of the French army, which was about 80,000 strong, and operating upon ground less than a myriamètre (2 leagues) in front.

General battle on the 11th in the morning.

The hostile General was evidently in an offensive attitude, and whilst the French were busy making these wretched dispositions, he was making reconnaissances and receiving reinforcements.

It has been already said, that he took possession of the entrance of the opening by the heads of his columns, which maintained their position throughout the 10th. On the morning of the 11th, the general attack was made. Covered by a thick fog, Prince Eugene advanced upon the two woods on the flanks, and established his batteries: one of 40 pieces against the

centre, and another of 28 pieces against the left; the remainder was directed against the right, where artillery could be of no great effect; but he wished to draw off the attention of Villars from his left.

The battle began at 8 o'clock, as soon as the fog cleared off; on the part of the French it was wholly defensive, for they were confined and straitened in their position.

Under cover of the fire of his battery of 40 pieces, the Prince attacks the left wing with the elite of his troops; takes it in flank and rear, and after a bloody contest forces it from the border of the wood of Sars. From that moment the intrenchments on the front were uncovered by the left, and the centre was on the point of being forced to retreat behind the second line, when Marshal Villars flew to the left and endeavoured to regain the ground lost Being severely wounded, he was obliged to leave the field, devolving the command on Marshal Boufflers. The centre could no longer sustain the attack from the hostile right, and abandoned the intrenchments, which the enemy's centre immediately occupied. He quickly made openings through which his cavalry passed to form in battle in front of the household troops; but they were charged with such vigour as to be forced to repass the intrenchments under the protection of the fire of their infantry.

On the right the battle was maintained without losing ground. Some regiments of infantry even made a sortie from the intrenchments to charge with the bayonet, and had overthrown the enemy; but this gallant movement could not be followed up; it might have changed the fortune of the day.

Measures of Marshal Boufflers.

Marshal Boufflers might have taken a second position behind the intrenchments commenced in the plain, if all the corps of the left, on seeing their General wounded, had not without orders retreated on Quevrain and Valenciennes; this circumstance obliged the new commander to retire the centre and the right upon Bavai and Quesnoi. The French army was not pursued in its retreat; nor did the enemy discover its retrograde 'till the morning of the 12th.

Losses.

The loss on both sides was immense; that of the French was estimated at 15,000 men killed and wounded; and that of the allies at 18,000.

Relation.

This battle may be compared from the number of combatants, to that of Fleurus in the last war. For 200 years there had

not been fought so great a battle: the slaughter was greater than at Hochstadt or Turin.

Examination of the battle.

The loss of the battle appears to have been produced solely by the defective coup d'œil of the General, who did not know how to post his troops according to the nature of the ground; and did not fight at the favourable moment.

1st. Instead of allowing the enemy to assume the offensive, he should have preserved that attitude which circumstances had put in his power; and after the movement of the 9th, he should have passed the opening, held the heads of the woods, and given battle to the enemy on the 10th, in his camp at Cipley before the arrival of reinforcements.

2d. When it was determined to occupy the position of Malplaquet, there were two dispositions that could have been made, either of which was far better than that which was adopted. The first was, to have occupied the heads of the two woods with his wings, well furnished with artillery, abattis, and redoubts; to have seized and intrenched the farm and little wood that covered the front; and finally, under cover of these works and dispositions, to have acted against the enemy with 30,000 disposable troops. The second was to have occupied the two woods in strength, withdrawing the centre to the rear and forming a concave curve, and there await and draw on the enemy; thus bringing into action the numerous and fine French cavalry, under the protection of cross fires from the woods and flank batteries, &c.: this latter disposition the General seems to have had some idea of adopting*.

Battle of Denain won by the French, 24th July, 1712. (See PLATE VII.)

Though fortification exercised a distinguished and decisive influence in the battle of Denain, and the investigation of that memorable day properly belongs to the Third Part, it will ne-

* There is not a more defective disposition than that of a crotchet or *potence* thrown *forward*; particularly where its flank does not rest upon obstacles utterly impossible to surmount. An army might as well present itself in flank to the enemy; for the two dispositions are identical. The vice of such a disposition is ten-fold in a camp or intrenchment. The allies ought to have beaten Marshal Villars in this position with one third or one quarter his force. Their attacks upon his centre and right should have been only false attacks, whilst their main body crushed the *potence*. Had these measures been taken, the loss of the allies would have been trifling, whilst that of the French would have been enormous.—See *Jomini* on the battles of *Prague*, *Kollin*, and *Leuthen*.

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vertheless furnish us a third example, to show how the project of a great attack should be executed by acting against a line of operations badly directed and ill defended. It is difficult to believe that so great a General as Prince Eugene, should have so essentially offended against the rules of war.

After capturing Bouchain and Quesnoy, Prince Eugene invested Landrecies on the 17th July, 1712: it was the last fortress on that part of the frontier. He established his magazines at Marchiennes, and his line of communication passed through Denain, the bridge of Prouy, and Solesm. From Denain to Landrecies, it was covered by the Selle; and from the former to Marchiennes, between the Scarpe and the Scheldt, it was covered by two parallel lines of intrenchments established against the garrisons of Valenciennes and Cambrai, which places were not yet in the hands of the enemy. Denain, on the left bank of the Scheldt, was enveloped by an intrenched camp on which rested the two lines that we have mentioned; the bridge of Prouy was covered by a strong tête de pont. The fortress of Landrecies was invested by a besieging army about 20,000 strong, whilst Prince Eugene with an army of 30,000 men remained in observation between Landrecies and Denain. Eight thousand Dutch troops were in the camp of Denain; and 6,000 men were in the double intrenched lines. The army of the Prince had just been greatly diminished by the retreat of the English.

Remark

Marshal Villars, at the head of an army 60,000 strong, proposed to raise the siege of Landrecies by a skilful attack upon the line of operations and magazines. By various apparently offensive movements on the left of the Sambre, he made feints of passing that river to attack the line of circumvallation on the right bank; he threw bridges across, and reconnoitred very closely with the reserve of dragoons. Prince Eugene, to better watch these menacing movements, approached close to Landrecies; thus eloigning his right more than four leagues from Denain. Marshal Villars seized this favourable moment, and in the evening pushed forward a corps of cavalry to take possession of all the passages of the Selle; detaching at the same time a body of infantry, cavalry, artillery and pontonniers, to move rapidly upon Neuville, above Denain, and there throw a bridge across. In the night the whole army marched upon Neuville, and by 8 o'clock in the morning the troops were able

to defile over the bridge. As soon as a sufficient number of squadrons and battalions had crossed, they marched against the double intrenchments, and carried them sword in hand, capturing an immense convoy on its road to Denain. The lines being forced, Marshal Villars next attacked the intrenched camp of Denain, to the succour of which the Prince was marching with great speed. The tête de pont of Prouvy was carried; and notwithstanding the Prince made the greatest sacrifices to retake it, it was impracticable. After a severe contest the intrenched camp was forced, and the Dutch troops totally destroyed. The French General then taking a defensive position along the left of the Scheldt, caused the magazines of Marchiennes and St. Amand to be attacked and carried; thus raising the siege of Landrecies, resuming the offensive, and repairing all the disasters of the campaign.

Examination of the operation

We see at the first glance the causes of the complete success of the French army. The enemy's line of operations was badly chosen, its flank being exposed to the direct movements of the French, whilst its position between the strong places of Valenciennes and Cambray was very dangerous; the small fortress of Bouchain was inadequate to its protection; and finally, the places in which the magazines were deposited were not strong enough.

Battles of Dunkirk and Hondscoote, on the 2d and 8th September, 1793 (See PLATE IX, and its table of reference.)

Notwithstanding the repugnance that we feel to refer to any of the battles in which we ourselves have served, yet we will take as examples the battles of Dunkirk and Hondscoote, fought on the 2d and 8th September, 1793. Our young readers will pardon this digression, to which we are led by many reasons; 1st, the duty we feel to dispel the prejudices existing against General Houchard; 2d, the conduct and details of these operations being little known, they may be involuntarily misrepresented in our military annals; and this the love of truth urges us to preclude; 3d, these operations form a remarkable epoch, for ever since the armies of the republic have marched from victory to victory, and the wars of France have been conducted on safer principles and grander combinations.

Preliminary remarks, and operations.

We said (art 63 and 65) that the army of the north was 40,000 strong, including 5,000 cavalry; that it had retired from Cæsar's camp to the position of Gaverelle, whence it watched the movements of the enemy; that the combined armies had been most injudiciously separated, the English moving

upon Dunkirk, and the Austrians upon Quesnoy; and lastly, that it was in the power of the French forces to attack either of these armies.

About the 20th August, 1793, the English army, nearly 50,000 strong, inclusive of 6000 cavalry, took post before Dunkerque, Bergues, and Wormhout; having previously forced the camp of Ghivelde in advance of Dunkerque, taken Hondscoote, and occupied all the posts on the Yser. From the 10th August the enemy had been harassed by a French division of 12,000 men, that had followed him closely, and by attacking his left flank, endeavoured to impede his march. In these attempts the division of Lille, supported by the corps of observation, fought several battles: this latter corps was to occupy the position of Cassel, which was to serve as a strong hold and become the point of departure of the line of offensive operations.

Plan of attacking the English army.

To attack the English army it was necessary to wait, 1st, for the arrival of the reinforcement drawn from the army of the Moselle; 2d, until the enemy had disembarked his artillery and battering train, &c. as he would then more obstinately maintain his position before Dunkerque, and his retreat become more difficult. These events did not occur 'till about the 1st September; so that we had some days to prepare and combine the means of executing the attack.

First plan of attack (See map of the Frontier, & PLATE IX)

The first plan proposed to the General was, to attack the advanced posts that covered the camp of Menin, to occupy this ill fortified place and the bridge across the Lys, then establish a line of operations by Lille, Turcoin, Roncq, and Menin, and rapidly descending in columns on Furnes, take the English army in rear, and cut off all retreat but by sea. Preparatory to this grand operation the French General caused on the 25th August the advanced posts of the camp of Menin to be attacked; but of all these attacks, that only on Turcoin succeeded; this large post was secured by the division of Lille.

Subsequent attacks by the English; opening of the trenches before Dunkerque.

On the 22d August the British army attacked Wormhout, and cut the communication between Cassel and Bergues. The division in observation then put itself on the defensive behind the canal of Colme, to cover the interior communication with Dunkerque, and prevent the completion of the circumvallation. On the 26th of August the trenches were opened 600 mètres (670 yards) from the walls, and the first parallel and several

batteries laid out. The enemy attempted several times to reconnoitre, but were quickly repulsed by the garrison and citizens.

Second plan of attacking the English, put in execution

The government, very much alarmed for the fate of Dunkerque, which the Duke of York could have carried by assault, urged and prevailed upon the French commander to make the most direct and speediest attack. Consequently the first plan, which was undoubtedly the best, was abandoned; and it was determined that a division of 12 battalions and 2 regiments of cavalry should remain in the position of Gaverelle, and that the remainder of the army should march on the camp at Cassel. This movement was executed between the 2d and 4th September; and the division from the Moselle being reported to arrive on the night of the 5th, it was resolved to make a general attack on the 6th September.

Mode of directing the attack from Cassel.

There were two modes of succouring Dunkerque from Cassel: 1st, by carrying the army behind the Colme and Dunkerque, and debouching from this species of intrenched camp attack directly and in front the English army intrenched on the Downs; 2d, or, by a skilful attack calculated to avoid the hazards and consequences of a general battle, by following the right bank of the Yser, forcing a passage of this river, and attacking all the posts between it and the Moors, take the British army in rear and compel it to a precipitate retreat. This latter plan suited the state of the French army, which it was necessary to economise and spare for subsequent operations. It was adopted by the General in Chief, and all the instructions thereupon were digested and transmitted to the different Generals of corps.

General dispositions for the attack; order of battle in movable columns

In a country full of hedges, ditches, brooks, and woods, like that in which the army was now about to operate, a general action could consist only in several attacks of separate positions and intrenched posts. We were bound to suppose that the enemy would be in great strength along the Yser, between Bambeck and Roesbruge; that he would occupy Poperingue with an advanced guard; and that he would dispute the woods and causeway between this latter place and Roesbruge. Consequently a train of pontons was to follow the main body, to form a bridge for the passage of the Yser by main force.

Observation respecting the fortress of Ypres.

The fortress of Ypres being precisely upon the right flank of the line of operations and connecting the British with the Dutch and Austrian armies, it was necessary to mask this dangerous

debouchè. Orders were sent to all the Generals commanding camps and strong places from Douay to Maubeuge, to feign offensive movements during the 7th and 8th of September, to prevent the Prince of Cobourg from detaching any considerable reinforcements to the succour of the English during the three or four days that the operations might last.

The line occupied by the French army was about 5 myriamètres (10 leagues) in length, extending from Bailleul to the sea; but interrupted by Wormhout, which place was in possession of the enemy; its numerical force was about 42,000 men of which 4000 were cavalry, with 4 companies of horse artillery, and 3 divisions of position, each with ten pieces. The army was formed into 5 corps, each to attack different points.

The *first* was the principal van guard commanded by General Hedouville, and composed of 9000 light troops, including 1500 cavalry; it occupied the position of Steenworde. There was in this van guard a corps of 3000 rangers of the country (*chasseurs du pays*), commanded by Colonel Vandamme.

The *second* was the main body in two divisions, commanded by General Jourdan, and composed of 18,000 men; including a special van guard of 3000 light troops under General Collaud. This corps occupied Cassel.

The *third* was a corps of 6000 men, of whom 500 were cavalry, occupying the position of Bailleul and intended as a flanking corps, and to constitute the right wing of the order of battle.

The *fourth* was the division of General Landrin, 6000 strong, including 500 cavalry, and occupied the causeway from Cassel to Wormhout; this corps was destined to form the left wing of the order of battle.

The *fifth* was a corps of 4000 men, principally composed of dismounted gendarmerie, and commanded by General Leclair; they were posted on the defensive behind the Colme, and considered in the order of battle as a flanking corps on the left.

Order of attack with respect to the ground (See PLATE IX.)

The order of attack in relation to the ground was thus:

The van guard was ordered to march from Steenwoorde on Poperingue, to clear the woods, and endeavour to pass the Yser at Roesbrugc. Colonel Vandamme was ordered to march from Steenwoorde on Reninghelst and drive the enemy from

thence, in order to facilitate the passage of the right division; and then wheeling to the left on Poperingue, to rejoin the advanced guard.

The right division moving from the camp of Bailleul, was to march by Reninghefit after the corps of rangers (*chasseurs*) had defiled through; then rapidly inclining to the right on Ypres, cut the communication between this place and Poperingue. This corps was followed by a division of 10 pieces, to endeavour to burn Ypres; and if the moment was favourable, was to carry it by assault.

The division of the left wing was ordered to make on the first day a false attack upon Wormhout; and on the 7th, at break of day, to carry it by storm.

General Leclair had orders to debouche from behind the Colme as soon as General Landrin had re-established the communication, and to march from Bergues along the canal towards Hondscoote as soon as rumour and the thunder of artillery announced the beginning of a great battle.

Lastly, the main body was to march from Cassel upon the camp of Houtkercke, to scour the right bank of the Yser, and certainly force the passage of that river.

General attack, 6th September.

On the 6th, in the morning, all the columns were in motion, and entered the country occupied by the enemy. At 7 o'clock General Collaud reconnoitred the position of Houtkercke, which was occupied by 2000 Dutch and Austrians, supported by an English regiment. After a warm fire of musketry and artillery, this post was carried by the bayonet; the Austrians retiring upon Ypres across the woods of Poperingue, and the English and Dutch falling back upon Herzelle and Bambeck.

Course of the operations.

According to the general plan, the main body was to march on Roesbruge by Proven, and the van guard under General Collaud had already taken this direction when the General discovered the enemy retiring upon Herzelle; fearing to leave these troops on his flank and rear, we marched by the left against the camp of Herzelle; the attack upon it and the village, was furious; it was twice taken and re-taken by the bayonet.

The enemy's corps, consisting of 4000 English and Dutch, retired in good order upon Bambeck, a village on the left of the Yser with a stone bridge covered by a battery of 3 three pounders, and flanked by pieces of small caliber posted on the

sides of the hill. We quickly drove in the outposts and were warmly cannonading the tête de Pont with 2 eight pounders, when the attack was suspended for more than two hours by a terrible storm that overtook us. As the enemy continued obstinately to defend the tête de Pont of Bambeck, a battalion crossed the Yser at a ford above, and co-operating by a flank attack with an impetuous charge made upon the tête de Pont, the enemy was put to flight, and abandoned the position. Meantime General Hédouville had passed the Yser at Roesbruge, after a feeble resistance from the enemy, and marched upon Ost Cappel to connect his advanced posts with ours. On entering Bambeck at sun-set, we supposed that the General would there rest the troops after the successes of the day; but how great was our astonishment when we saw the whole army file by, and heard the soldiery say, that they were going to Bergues! We testified to the General our surprise at a march without a single object, and which carried us away from the true direction; he concurred with us in opinion, but was afraid that he might be blamed by the representatives of the people, if he did not attack Rexpoede before night. We therefore marched against this village, which the enemy abandoned after a vigorous charge with the bayonet; throwing his infantry into the woods and orchards, and posting his artillery in battery on the roads, with his cavalry in battle in the rear. The rain continuing and night having come on, it was impossible to properly establish the outposts and bivouacs. The soldiers took shelter in the houses, and the cavalry took post in the centre of the village. At 10 o'clock we were attacked at all points; the enemy penetrated into the village; and several corps were so mixed with the enemy, that the Adjutant-Colonel Coquebert was taken in attempting to reconnoitre the road to Ost Cappel. The army was compelled to fall back on Bambeck. We recrossed the Yser at break of day, and took post between Houtkercke and Herzelle. The van guard on the 7th, after the retreat of the main body, advanced on Rexpœde, attacked the enemy, and after a severe and long contest compelled him to retire by Killem into Hondscoote.

Operations and attack of the 7th.

The 7th was employed in providing for the subsistence of the troops, and awaiting intelligence from the right and left divisions. The right division had not moved on Ypres; for in consequence of a most vexatious misunderstanding, the General

commanding in the camp of Bailleul had not received orders to put himself in motion in the night between the 6th and 7th. Although the General in chief could no longer flatter himself with the hope of surprising Ypres, as the Austrian column that had been cut off at Houtkerque had entered the place; nevertheless he felt the necessity of covering the right flank of his operations, and dispatched orders for the division to march instantly on Ypres.

Order of attack on the position of Hondscoote

It was resolved in a council of war (*Conseil du General*) that on the 8th we should re-cross the Yser below Bambeck, and move on the principal position of Hondscoote, which covered the head quarters at Furnes and the left flank of the grand army encamped between the Great Moor and the sea. By possessing ourselves of this key, it was evident that the British army would be forced to retreat behind Furnes to oppose to us its front; and that the whole of their besieging train and equipage would fall into the hands of the garrison of Dunkerque.

General Collaud was therefore ordered to move with his van guard by Roesbruge on Hondscoote, and to reconnoitre the position; and General Jourdan was ordered to pass the Yser below Bambeck, and move with the main body on Hondscoote.

Attack on Hondscoote the 8th September, 1793.

The General of the van guard gave information, that the left division had forced Wormhout and Wilder; that the flankers of the left had debouched from Bergues and carried many of the enemy's posts along the canal of Hondscoote; and that he had detached Colonel Vandamme towards Hondscoote.

The columns arrived within 1200 mètres (1340 yards) of Hondscoote on the 8th September, at 9 in the morning. According to information from the country-people and spies, this position was but weakly intrenched, and de ended by only 5 to 6000 troops with 15 pieces of artillery; but the fact was, that the troops forced from the several positions on the 6th and 7th had fallen back on this post. and altogether formed a corps of 11 to 12,000 men; besides in the evening of the 7th, the Duke of York had detached 7000 Hanoverians from the grand army, and they had entered Hondscoote about midnight. Thus this position, defended by 17 to 18,000 men, with upwards of 20 guns and howitzers, was attacked by 20.000 men on most disadvantageous ground. The command of the right of the attack

was confided to General Collaud. On this side the enemy were so covered by woods, hedges, and ditches, and by 6 pieces of artillery, that we could not hope to force this point. Colonel Vandamme was charged with the attack on the left, which was covered by an advanced redoubt and the end of the canal. General Jourdan commanded in the centre; here the enemy had a battery of 12 pieces that enfiladed the road and played upon a grove on the left of it. A little in rear of this battery there was a house which the enemy had neglected to destroy; and on the right and left of the road there were practicable woods, hedges, and ditches: the ground gently declined towards Hondscoote. The topographical description shows that Hondscoote could not be surrounded; accordingly the enemy preserved two communications with his rear; one by the right of the canal, through Houtheim, and the other on the left along the moor.

The enemy did not establish any exterior defences or outposts, for fear of our obtaining intelligence from prisoners of the arrival of the Hanoverians; accordingly we were enabled to reconnoitre very closely the batteries and intrenchments. Ten pieces of artillery were brought forward against his grand battery of 12 pieces, and produced an astonishing and to the enemy a most unexpected effect; the splinters of the house we have mentioned, wounded great numbers of the enemy's artillerists. As soon as our artillery had in some degree slackened the enemy's battery, the troops were formed on the right and left of the road and attacked the forces that had come out of Hondscoote to defend the woods and approaches to the intrenchments. For two hours the Hanoverians, supported by the English, firmly kept their ground; but they were at last so hard pressed that they sought shelter behind their intrenchments. General Jourdan, in endeavouring to follow up this success, attempted to carry the grand battery by the bayonet; he was wounded and put *hors de combat*, as likewise were Generals Collaud and Mingaud.

At this critical moment the fire seemed to slacken on both sides, on the right and in the centre; but it was renewed with increased fury on the left, where the attack was furiously urged by General Leclair, who with his flanking corps attacked the redoubt, in order to join Colonel Vandamme.

The General in chief ordered the line to be re-formed, and

the intrenchments to be attacked with the bayonet at the charging step; and collecting himself 2000 sharp shooters, advanced the 17th regiment of cavalry, at the head of which he was about to charge, when we perceived that the enemy were making dispositions to retreat. The charge was furiously sounding on the left, and the grenadiers penetrated into the grand battery at the same moment that General Leclair's and Colonel Vandamme's troops entered on the left, closely pressing the enemy, who retired in the best order. General Leclair on this occasion conducted with great ability; and much of the success of this memorable day is attributable to him. Having heard a great firing on the side of Hondscoote, he directed his march upon that place; and after carrying by the bayonet a small corps in observation, he arrived in front of the redoubt on the left that was surrounded by a pond: he attacked it and took 500 English prisoners; and then uniting with Colonel Vandamme, made an assault which decided the fate of the battle. General Collaud's van guard pursued and harassed the enemy as far as Houtheim; and the advanced guard under General Hedouville, which was arriving with great speed, defiled through Hondscoote by Houtheim towards Furnes: at 4 o'clock we were masters of the position of Hondscoote.

First result of the battle; position of the respective armies.

The enemy lost in the battles of the 6th, 7th, and 8th, about 6000 men, 3 standards, and 9 pieces of cannon. Our loss was 1500 men. But the principal advantage of the battle was, that we were now in a position that menaced the English head quarters and the left flank of their army, from which we were separated only by the moor, a league and an half wide.

Conduct of the Duke of York during and after the battle of Hondscoote.

The enemy were so fully sensible of the importance of Hondscoote, that he had established a chain of intelligence across the great moor; and no sooner did he learn the fate of the battle, than he prepared to retreat behind the canal of Loo at Furnes, and to abandon the siege of Dunkerque.

Conduct of the French General after the battle.

Towards night the General reconnoitred the borders of the moor, and with good reason judged that the Duke of York must be in full retreat; and that as he had but a very short line to move on, it would be impossible to counteract him. The General of the van guard, posted at Houtheim, confirmed this opinion by his reports, and the manner in which the enemy reinforced themselves in his front. Having discovered the debouché of the enemy's line of communication across the moor.

we proposed to the General to dispatch all the cavalry with infantry mounted behind them, under the command of Colonel Vandamme, who was acquainted with the country, to fall in the night on the left flank of the enemy ; but the General did not think it prudent to hazard the few cavalry that he had. He consented however that the Colonel should cross the moor with 60 cuirassiers, and reconnoitre and alarm the enemy. This officer passed the moor, debouched into the plain, and fell in with the baggage of the English army which was precipitately retreating upon Furnes. Supported by detachments from the garrison of Dunkerque, he fell upon the escort, and captured the greatest part of the baggage.

Retreat of the British army behind the canal between Loo and Furnes, in the night of the 8th to the 9th of September; and raising the siege of Dunkerque.

Thus at 2 o'clock in the night between the 8th and 9th September, the English army took post behind the canal from Furnes to Loo, with its front towards us ; having, after 21 days of open trenches, raised the siege of Dunkerque, abandoned in their camp 52 pieces of artillery, principally 24 pounders, 300,000 lbs of powder, their tents, and all the besieging implements and equipage : they had only completed the first parallel and a battery of 6 guns, which had begun to fire red-hot shot.

Examination of the preceding operations.

A short examination of these operations will show how absurd is the opinion that ignorance of facts has propagated— " that General Houchard could have turned the English army, " *and have compelled them to lay down their arms!*" On the night between the 8th and 9th, Colonel Vandamme found no other troops between Furnes and Dunkerque than the rear guard of the enemy ; this proves that the English army began their retreat at the same time that the corps charged with the defence of Hondscoote retired on Houtheim and Bulschamp, and that on the morning of the 9th the British army occupied a position behind the canal from Furnes to Loo. 'Tis true we might have pursued them as far as Nieuport, Bruges and Ghent ; but it was of far greater importance to succour Quesnoy, which was besieged by the Prince of Cobourg ; consequently the result of the operation was as complete as possible.

The only mode of reversing the British army; influence of the errors committed in the execution.

The only mode by which the British army could have been turned and driven into the sea, was by taking a line of operations by Lille, Menin, Loo, and Dixmude ; as we have before detailed. But the government having prevented the General from executing this plan, which would probably have succeed-

ed; and having approved of the more direct operation from Cassel, nothing more could have been done than was effected; and though some errors were committed in the execution, yet they had no influence on the principal result.

An example.

The operations for raising the siege of Dunkerque were on a very confined space, and were planned and conducted on those principles that were illustrated in the following campaigns with so much genius and success.

Let us conclude this narrative with the tribute of a few words to the memory of General Houchard. He was an honest man, brave, and loyal to his country; and, like the unfortunate Custine, was basely sacrificed by the passions of mankind. We leave to history the task of designating their rank among the warriors who have deserved well of their country.

Epitomè of the last campaign of Turenne, from 20th May to the 27th July, 1675 (See PLATE X. and the map of the Rhine.)

To give the students and young officers of all arms some idea of the manner of directing and combining the operations of a campaign, we will display before them an epitomè of the last campaign of a hero whose virtues and talents will be for ever cherished in the memory of Frenchmen, and honoured by all nations. In this campaign. Turenne rivalled himself. It will here be easy to observe the influence of the coup d'œil; the modifications which the strength of an army sustains from the choice of lines of operation; and the variation produced in the strength of a front, by the respective positions of the lines of the centres of action. This campaign was in 1675, and lasted from the 20th May to the 27th July, the day on which this great man fell.

Preliminary details.

In the campaign of 1675, Turenne found himself opposed by an antagonist whose virtues and talents rendered him worthy of contending with this illustrious man. Montècuculi alone was able to counterbalance the advantages that Turenne had lately obtained with inferior forces by the successive victories of Sintzheim, Entzheim, Mulhausen, and Turckheim.

Strength of the two armies.

The two hostile armies were of about equal force; the French being nearly 34,000 strong, and the enemy about 38,000; of this number 15 to 18,000 were cavalry. It must

Neutrality of Strasbourg.

not be forgotten that the city of Strasbourg was *neutral*, and inclined to give Montècuculi a passage across the Rhine: this induced him to hope to be able to carry the war to the left bank of this river, and to secure the subsistence of his army.

The plan of the French General was, to prevent the citizens of Strasbourg from favouring the designs of the enemy, to carry the war to the right bank of the Rhine, and to compel Montècuculi, by force of arms, to retreat through the gorges of the mountains into Wurtemburg. The conception of such a plan belonged only to a genius like Turenne.

Opening, and journal of the campaign, from the 20th May.

About the 20th May, 1675, the campaign was opened; Montècuculi pitching his first camp at Losheim on the right bank, opposite Spires. Turenne marches from Schelestat, encamps at Benfeld; and with 1000 men moves on Strasbourg, to pervent that city from giving a passage to the Imperialists.

Montècuculi makes a feint of investing Phillipsbourg.

Montècuculi, perceiving his project disconcerted, throws a corps over on the left bank, which takes post between Walshiem and Otterstatt, menacing Phillipsbourg with investment, and communicating by bridges with the camp at Losheim.

Movement of Turenne.

Turenne wishing to observe at the same time Haguenau, Strasbourg, and Phillipsbourg, moves down the Rhine, and encamps behind the Musbach, opposite Achenheim. He causes boats to be brought down to above Rhineau, opposite Ottenheim, and with great labour establishes bridges; on the 31st May he occupies the camp of Eresthein, opposite Ottenheim.

Bridges established opposite Ottenheim; camp of Eresthein, 31st May.

Montècuculi, on learning the offensive dispositions of Turenne, repasses the Rhine and returns to Losheim.

Movement of Montècuculi, 4th June

Finding the enemy distant from Strasbourg, Turenne forms the plan of passing to the right bank, and cutting off all their communication with that place. The bridges at Ottenheim being well established, Turenne passes the Rhine on the 7th and 8th of June, and takes post on the right bank behind the Kintzig; at the same time occupying the important post of Wilstat, which the enemy had neglected to secure; and intrenching himself in the midst of morasses and woods: thus cutting all communication between Khell and the enemy.

Turenne's plan of assuming the offensive on the right bank: his movements 7th and 8th June; encamps behind the Kintzig.

Montècuculi's movements on the 11th June.

Montècuculi forseeing the manœuvres of his adversary, ascends the Rhine by forced marches and encamps at Lichteneau; his centre behind Ulm, his right upon the Rhine, and his left in the woods. Finding Wilstatt taken, he perceives his error in not having occupied it, as he did Offembourg, of which Turenne could not get possession.

He forms the bold scheme of seizing the bridges at Ottenheim by Offemburg, on the 13th and 14th June

This latter position induces him to conceive the possibility of turning the French right and seizing the bridges at Ottenheim. He marches from Lichteneau, passes the Renchen near

the mountains, occupies the camp of Urlaffen behind the Halchen, and next day marches upon Offembourg.

Turenne reconnoitres.

Turenne goes in person to reconnoitre the march of the Imperialists, and arriving at Urlaffen, discovers the critical position in which he is about to be placed. He changes the front of his army, placing the left upon the Kintzig and the right at Eckerwir, facing the enemy encamped behind the Kintzig; so that he could both watch his bridges and Strasbourg. The space thus guarded was 6 leagues, from Ottenheim to Khell and Wilstatt. The armies were now between the mountains and the Rhine, and only separated by the Kintzig.

The armies in presence of each other, 15th June.

Subsequent movements of Montècuculi, 15th June.

Montècuculi passes the Kintzig, and marches upon Ottenheim by the right of the great Scutter.

Count de Lorges marches with 10,000 men on the enemy's front

Turenne perceiving this menacing movement executing on his right, detaches a corps of 10,000 men who take post in front of the enemy and compel him to repass the Scutter.

Dispositions of the enemy to pass the Scutter 21st June.

The enemy throw bridges over the Scutter, and give out that they are going to attack the French.

Turenne's new dispositions: he removes his bridges to Altenheim 27th June.

Turenne thinking his position too extended, and wishing to concentrate a little more, causes the bridges to be brought down to Altenheim, where they are established and easier defended. He then causes bridges to be thrown over the Scutter on the right of the Imperialists, to alarm them for their communication with Offembourg, and compel them to retire under this fortified post.

Montècuculi retreats 26th June.

These dispositions frustrate Montècuculi's plan of attack: he falls back on Offembourg, to be nearer Strasbourg and to procure subsistence.

Turenne's movements and dispositions, 27th and 28th June.

Turenne, penetrating the enemy's design of moving on Khell, provides for the security of the bridges at Altenheim, and passes the Kintzig; he encamps with his right at Neumulh covered by 6 squadrons, and his left on the road to Khell at Boteswirr: he occupies the post of Bischen on the Halchen by a detachment.

Remark on this bold movement

If Montècuculi, instead of marching on Urlaffen and there intrenching himself, had suddenly marched on the bridges at Altenheim whilst Turenne was passing the Kintzig, it is probable he would have had time to have forced them before Turenne's army could have come up; but the age and infirmities of this great man deprived him of the activity and vigilance of his adversary.

Turenne changes his position, resting his right at Boteswirr, with his left towards Lins, and having the stream in his rear. He assembles all his troops, leaving only the necessary infantry and 10 squadrons to defend Wilstett. 29th June.

The enemy attack and carry the post of Bischen; but the French retake it. Attack on Bischen.

Montecuculi, embarrassed for subsistence, forms the scheme of re-descending the Rhine to endeavour to re-establish his communications with Strasbourg by the left bank. He quits his camp at Urlaffen, passes the Renchen at Renchen itself, defiles by Acheren, Bihel, and Lichtenau; and by this great detour comes and takes post at Renchenloch, his right on the Rhine, and his left on a wood. His head-quarters are at Schertzen. Renchenloch, the mill, and the banks of the Renchen, are fortified by abattis; the left is covered by a redoubt. Montecuculi approaches the Rhine to find subsistence, 3d July.

Count Caprara holds Offembourg with a strong corps.

No sooner was Turenne advised of the march of the enemy, than he decamped from Boteswirr, and passing through Bischen, puts himself in battle array on the plains of Freystett. He makes a strong reconnaissance of the enemy's position, in the course of which the French climb the enemy's intrenchments to observe them. The front of the French army was covered with woods, its left rested upon the Rhine, and the right was thrown back by Hoschen on Bischen. The two armies are only 300 mètres (340 yards) distant from each other; but they are separated by the Renchen, and by woods and morasses that the rains had rendered impracticable. Turenne's movement, 5th July.

Turenne, obliged to extend his forces to procure subsistence, meditates upon a plan to compel the enemy to quit their position and retire from the Rhine. Having observed that the enemy guarded badly the banks of the Renchen, especially the post of the mill, he proposes to seize it; and for this purpose he selects a ford that a herdsman had shown him in this gloomy region, which he and his goats alone frequented. Turenne forms a plan of compelling the enemy to quit their defensive position.

In the night, five battalions march with light pieces and implements directly to the ford, guided by the herdsman, where they throw a bridge across and cover it by a redan; they intrench a small island, and throw up during the night some intrenchments along the Renchen. All this time the enemy are perfectly ignorant of these movements. Fresh troops relieve each other successively, and advance the works. Hamilton 15th July.

surrounds himself with abattis, and undertakes to defend the work with 3 battalions: he sends a detachment to the right, to occupy a more advanced and better look-out post.

18th & 19th July. Turenne fearing that Caprara may attack his right and rear, occupies Urlaffen with 6 battalions and 9 squadrons; and advancing across the woods with some battalions as far as Waghust, passes the Renchen and throws a battalion into the castle of Renchen with orders to repair it; thus cutting off all direct communication between Montècuculi and Caprara. He makes a road of fascines through the morass, to communicate from the posts of the Renchen with Waghust.

21st and 22d July: new dispositions of Turenne and his movements on the left of the enemy. Turenne covers the front of the camp of Freystett with intrenchments and palisades, so as to withdraw from it the greatest part of the troops; and with all the disposeable troops that he can collect, marches by the fascined road to Waghust, passes the Renchen, and takes post on the left of the enemy; his left supported by the Renchen, and his right on a brook and on the great causeway leading from Renchen to Nideracheren.

Montècuculi had determined to attack all the points of Turenne's position on the morning of the 23d. Montècuculi, ignorant of the latter movements of Turenne, had given orders to attack all points of his position on the 23d at break of day. Caprara, leaving Offemburg, was to have advanced to Waghust and taken in reverse all the intrenchments on the right along the Renchen, whilst Prince Charles of Lorraine attacked them in front. Four thousand men were to attack the posts occupied by Hamilton. Montècuculi in person proposed to force the defile through which the road from Renchenlock to Freystatt passes, and to penetrate into the intrenched camp.

All the columns were in motion in the night between the 22d and 23d, to execute this general attack, when 50 dragoons sent by Turenne that night to reconnoitre whether the enemy occupied Gamshurst, fell in with the van guard of Prince Charles who was marching against the intrenchments of Duplessis. Turenne being alarmed of the enemy's march, caused them to be suddenly attacked, and forced them to retire.

Ill success of the attack.

The column that was to have attacked Hamilton, lost its way; so that the signal for Caprara's attack was not made. This General arrived near Waghust, and hearing no noise, wisely retired.

Remark. Thus failed a plan of attack, admirably conceived, and worthy of the great genius that directed its execution. But for the

thick fog which favoured the retreat of the enemy, it is probable that Turenne would have destroyed a part of the enemy's army, by fighting it in detail.

Position of the French army on the 24th.

That part of the French army which had marched by the right, displayed in the meadow; its right resting on Acheren, fronting Gamshurst, and the left on a brook; two battalions were posted between the camp and the Renchen, to connect with Hamilton's posts.

Attack on Gamshurst the 25th July.

Turenne having most imprudently neglected to possess himself of the post of Gamshurst, on his right, Montècuculi immediately occupied it; this constrained the French General to attack it. The slaughter was tremendous; he then occupied it with 6 battalions and 2 brigades of cavalry, who were to guard the right bank of the Acheren.

Montècuculi is obliged to quit his position, and to select another that puts him in immediate relation with the corps at Offemburg: 26th July: he takes up the position of Nidersasbach.

By these last dispositions Montècuculi found himself surrounded in front and on the left, deprived of supplies, and only communicating with Offembourg by an immense circuit. He turns his attention to quitting his position for another that will enable him to form a junction with Caprara.

The position of Nidersasbach, at the entrance of the defile leading to Wurtemburg, appears to him to favour these views. He decamps in the night, passes the Acheren at Lichteneau, and pitches his camp behind Nidersasbach, with his left in front of Riegel, his right on a wood, and his front covered by a rivulet.

He despatches immediately 100 infantry to occupy the church of Nidersasbach on the other side of the rivulet, with orders to maintain it to the last extremity; and towards evening he leaves Riegel to be nearer Nidersasbach, which his troops occupy as fast as they arrive.

Movements of Turenne on the 26th.

Turenne, apprised of the march of the enemy, collects his different corps at Gamshurst, which he leaves on the evening of the 26th, to follow the enemy. He passes the Acheren at Nideracheren, leading in person the advanced guard; and on the morning of the 27th finds himself in sight of the village of Nidersasbach, on the rivulet of this name which flows through the village. On arriving he reconnoitres the post of the church and houses occupied by the enemy; but this post is too strong to be forced without great loss, being surrounded by walls and a muddy ditch, and supported by the Austrian troops who are momentarily arriving and forming behind the hedges.

After a few attempts on this advanced post, Turenne withdraws his troops and contents himself with cannonading it.

The troops of both armies are successively marching to occupy and display upon their positions. The forces under Caprara are seen descending the defiles of the mountains, and Montècuculi ranging them in battle as they arrive.

Movements of both armies on the morning of the 27th: dispositions of Montècuculi in offering battle.

Montècuculi posts his army in order of battle; his right covered by the post of Nidersasbach, faces towards Groswirr; and his left occupies a height in the direction of Obersasbach: this height was furnished with several pieces of position.

Turenne's dispositions.

Turenne, beholding the enemy forming in battle, makes his dispositions along the left bank of the rivulet that separates the two armies. He rests his right on a coppice wood upon a hillock and near very broken ground; and his left is supported by another strong wood very near Nidersasbach.

The infantry composes the first line, and the cavalry the second.

The artillery is distributed along the front of the first line, on some favourable acclivities. The baggage of Montècuculi's army is now seen filing through the gorges of the mountains towards Wirtemberg.

All the dispositions of both armies are completed towards one in the afternoon. Turenne after reconnoitring the position of the Imperialists, passes along the front of his army, and halts near Nidersasbach at the head of his infantry; he sits down under a tree which he had caused an old soldier to climb for the purpose of discovery.

Movements of the enemy menacing Turenne's right.

At two o'clock young St. Hilaire comes to inform Turenne, that the enemy are marching a corps by their left upon the little Kiln, and threatening to turn his right. On this report the General sends two battalions to support his right wing and take post at the Kiln; he sends orders to Count de Roye to observe the enemy, and give him intelligence of their movements. The latter in answer, requests the General to come and reconnoitre them himself. Turenne mounts his horse, and arriving on the height on the right meets St. Hilaire, the commanding general of the artillery, whom he asks whether he sees the enemy's corps on account of which he had been brought thither? St. Hilaire points it out to him, and at that moment a

Death of Turenne.

cannon ball strikes this illustrious hero in the breast, carrying off at the same time St. Hilaire's left arm. Montècuculi on

learning from a deserter the death of this great man, exclaimed in these remarkable words, "*He did honour to human nature.*"

Subsequent operations of the campaign.

After the fall of Turenne divisions arose between the French Generals, who were unable to follow up operations conducted with so much science and wisdom*. And the army, not knowing which of them to obey, commenced its retreat. Montècuculi regained quickly that ascendancy which his talents secured to him when opposed by Generals who though brave, yet by a false notion of glory sacrificed to their vanity the interest of the army and their country.

After several most obstinate combats, in which Count Lorges lost his life, the army repassed the Rhine ; and thus lost the fruits of a most glorious campaign. Montècuculi crossed over to the left bank, and established himself in Lower Alsace.

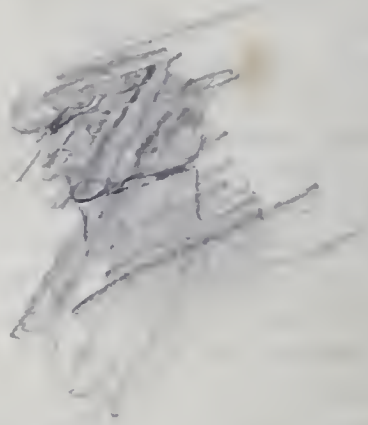
We will not comment upon the operations that we have just delineated ; the inspection of the map of the country, and the narration, sufficiently show the reason for every movement of either army ; and thence it is easy to deduce the principles and results that are connected with the science on which we treat.

We will produce other examples in the second part ; and for the present restrict ourselves to the preceding, which amply prove to the student and young officer, what a resource the art of fortification is in all the operations of war. The influence of the arm that directs and applies this art, will be still more powerfully felt by the study of its particular theory, which proves that this branch of military science requires a knowledge of all the others, and that they are founded upon its principles and maxims.

* The biographer of Turenne, in accounting for the retreat of the French army after his death, exclaims—"For the Viscount de Turenne was no "longer living to maintain the army beyond the Rhine." Such are the powers of greatness.—See *La Vie du Vicomte de Turenne.*

TRANSLATOR.

END OF THE FIRST PART.



TREATISE

ON THE

SCIENCE OF WAR AND FORTIFICATION.

PART II.

ON FIELD AND TEMPORARY FORTIFICATION.

CHAPTER I.

The considerations that give rise to Fortification; its use and importance; distinction between Temporary and Permanent Fortification; Duties of Engineers; the material and service of their arm; the Instruction of Engineer Officers; General Principles on the disposition of Works of Fortification, &c.

67. To what has been said of engineering in the preceding chapters, must now be added those illustrations and developements that constitute the theory of fortification, considered both as an *art* and an *arm*. This branch of military science is divided into infinite ramifications that connect it with all the mathematical and physico-mathematical sciences, and with all kinds of arms The theory of fortification is founded upon; 1st, mathematics, &c.: 2d, physico-mathematics, especially chymistry applied to the arts: 3d, all kinds of drawing, imitative and descriptive: 4th, the art of building, in relation to architecture and public works: 5th, the knowledge of the arms used for attack or defence: 6th, adequate and correct principles of tactics.

67 Considerations that gave rise to fortification and engineering: its importance and use in offensive or defensive war. (See arts. 24, 38, and 41)

The military operations and events that we have described, show that an army operating on a frontier, constantly views the nature of military sites under the relations of attack and defence; and that whenever the local circumstances do not favour the plans of the General, they must be modified and the ground put in relations with the action of the active arms, in order that they may produce the greatest effect.

This manner of viewing ground and modifying its form and properties, constitutes the *art of fortification.* The application of this art to the operations of war, gave birth to the *arm of engineering;* the sphere of which is so wide and extensive. By this arm the flanks or rear of an army or position are protected or secured, a field of battle covered with obstacles or fixed batteries, gorges and defiles closed up, torrents, streams, and rivers passed, communications secured, and strong places constructed to increase the strength of a frontier, to serve as a place of arms and to protect and support lines of operation. By this arm these same strong places are attacked or defended. The arm that is employed for these great purposes, is essentially conservative; its constant object is to defend the weak against the strong, to attain the end proposed by the General at the least cost of lives, and, if we may thus express it, to impart a *momentum* to the active forces.

Although offensive war may, strictly speaking, be carried on without the use of fortification, because it is supposed that the army on the offensive can supply its place by *moving forces;* nevertheless it must be recollected, that in most circumstances its detachments would become so numerous as to greatly weaken the army. Besides in offensive war, an army is frequently on the defensive at many points which must be strengthened by the labours of the engineers: there are even offensive operations (as we will show), which, without the aid of fortification, must miscarry. But it is chiefly in defensive war, the conduct of which entirely depends upon this art and its combinations, that the necessity of fortification is most felt; by it an equilibrium is constantly preserved between the two forces, changes of position do not draw down destruction upon the weaker army, and a campaign is made without the latter being obliged to give battle.

Fortification distinguished into temporary and permanent.

It follows, that fortification is divided into two kinds; the *first*, comprising all the daily or momentary works executed in the progress of an army to favour its operations, and constituting *field* or *temporary fortification;* the *second* comprehends all kinds of solid and permanent works used in the construction of strong places, forts, and permanent posts, and constitutes the *permanent* or *fortification of fortresses.* The first being the simplest, shall first receive our attention, and will serve as an introduction to the second, the elements and principles of

which are more complex. The duties of the engineers' service, are;

Functions actually belonging to the arm of engineering.

1st, The construction, repairs, and preservation of fortresses, of permanent military posts and ports, of canals cut through frontiers, &c., and of all buildings connected with the war service.

2d, The military topography of frontiers, conjointly with the geographical engineers; and in conjunction with superior officers of the staff, reconnaissances and memoirs on the strength and organization of the defence of frontiers, maritime and inland. By these latter labours are determined the points that should be occupied by strong places of the first, second, and third lines, by intrenched camps, and by all other military posts: the advantages which may be derived from water courses, as defensive obstacles or means of transportation, are pointed out.

3d. The formation of the plans, designs, and estimates necessary to regulate the expenditures of all projected works for the war service. These are the duties in time of peace.

4th. Arming and providing, in concert with the artillery, with munitions of war and subsistence, the strong places threatened by the enemy.

5th. Establishing, conjointly with the artillery, bridges across streams and rivers, to facilitate the operations of an army.

6th. Reconnoitring military positions and communications, in order to intrench them pursuant to the plan of the General; and reconnoitring strong places intended to be besieged.

7th. The direction and construction of all works executed in the progress of an army, and of those by which siege is laid to strong places. These four latter branches form the war service.

68. The service of engineering, and its material.

68. Among all nations that have made war with art and method, there has ever been one branch of the science devoted to the attack and defence of fortified towns, and professed by men sufficiently skilful in the mechanic arts to direct the construction of works and of the warlike machines invented and used for this species of attack and defence. These few estimable men, who are at the same time artists and soldiers, have always been called *engineers*.

In antiquity, as in early modern times, engineers did not form a permanent corps whose relations with the other arms were accurately determined. They were separately attached

to Generals, and employed by governments according to circumstances. It was reserved for the celebrated Vauban and for the age of Louis XIV, to organize the engineer corps and establish it upon a solid basis.

Before the invention of gun powder the engineers employed in the operations of war assembled together and served under the orders of the Grand Master of the Cross-Bows. After the invention of gun powder and artillery, they did duty under the direction of the Grand Master of Artillery. Henry IV and Louis XIII had several able engineers, such as Errard de Bois le Duc, the Chevalier de Ville, Count Pagan, and others; they educated a great number of students (*élèves*), with whom Vauban formed the corps of engineers. But without the pains that he took to draw into this corps all the officers of intelligence whom he met with in the other arms, he would have found it difficult to supply the wants of the service, which had increased astonishingly by the numerous sieges of those days, and by the immense numbers of public works of all kinds erected on the frontiers. After Vauban's time the number of engineers was successively augmented to about 400. At this time all the appointments were independent of military grades, to which engineers were promoted according to their service in war and the brilliant actions in which they had participated. These appointments were those of directors, chief engineers, and ordinary engineers; the service in war was performed by brigades.

The offices of engineers, and their military grades.

In 1755 the engineers were united to the artillery; but this union having produced great embarrassments and inconveniences to both services, they were separated in 1756; the artillery retaining the sappers and miners. In 1759 these two latter corps were restored to the engineers, as being immediately dependent on their service; but were soon after re-united to the artillery, to which they remained attached 'till the last organization, by which they were constituted troops of the engineer corps.

By the regulation of 1776 the offices or appointments were suppressed, and the engineers took the title of officers of engineers; they were all commissioned, and formed into 21 brigades, each of 15 officers. The service in time of peace is by directions and sub-directions (*directions et sous directions*).

Title of officer of the engineer corps, substituted for that of engineer (See arts 24 and 25)

Before the formation of the school for the Theory and Practice of Engineering, the preliminary acquirements of engineers

Instruction of engineers; school of engineering.

consisted only of the elements of mathematics and geometrical drawing. These were inadequate to the discharge of the various and important duties of engineering. So strongly was this fact perceived about 1740, and such evils did it produce, that the government adopted the plan of establishing a school, under the direction of officers of great talents and experience, at which the students should be instructed by celebrated professors in the theory and practice of the art; and where their fitness and qualifications would be judged, and their habits moulded to military discipline. This admirable plan was executed in 1748, which is the epocha of the foundation of the School of Engineering. All the materials for instruction were compiled, composed, and brought together, by the researches and joint labours of the commandants and professors. The results expected from this establishment have constantly surpassed even the hopes of government. The school of Mézières is the admiration of neighbouring nations, and no state has been able to raise the service of engineering to such a height as it has attained in France.

It was the success of the school of Mézières that originated the idea of a school on a more extensive scale, in which should be united in one general course of instruction, all the theoretical knowledge relating to the several branches of public service. The Polytechnick school has flourished like that of Mézières; and the experience of several years has proved that the modes of instruction and choice of the materials at this school, prepare the students for the schools of practice in a manner that leaves little more to be desired.

School of practice for artillery and engineers.

We have seen, in Chap. VII, that the artillery had several schools of practice attached to regiments, and in which the officers of that arm applied the theory to the branches of the art. Besides these regimental schools, there was instituted a school for theory and practice, at which all the students completed their studies before being employed in the corps composing that arm. The multiplied relations of the two arms, and their reciprocal dependence on each other, determined the government to have but one school of practice for both services. In this school, which merits by such numerous titles the fostering care of government, mining is considered as a dependent of engineering. The suppression of the separate school for miners, has naturally blended it with this school, the admirable

administration of which, as relates to instruction and other branches, must necessarily produce very distinguished officers.

The labourers employed by the engineers.

In peace, the officers of engineers employ proper civil workmen on their various works; and they use the detachments furnished by the commandants of infantry corps, as common fatigue men.

In time of war the workmen of the country that is the theatre of war, are draughted; and detachments of infantry are added to watch them. The troops of the engineers' corps conduct and superintend the works, under the orders of their officers, to whom all the workmen must yield obedience.

The material of engineering.

The material of engineering is composed; 1st, of all kinds of implements used for every species of work; 2d, of all machines used in the construction of works; 3d, of all the kinds of materials used in building: these materials are of infinite varieties, and the engineer should select them properly and according to the object to be attained by the work; 4th, all the instruments required by engineers to make the maps and drawings accompanying projections, reconnaissances, and memoirs.

69. Principles of the general dispositions of engineering on military sites.

69. When an army on the defensive occupies a position either to hold in check a stronger and more numerous army, or in which to give battle, the site ought to be so prepared and disposed by the engineers, as to reduce the points of attack of the position to a very few; in order that the General may direct the greatest portion of his active forces towards the assailable points against which the enemy is constrained to make his attacks. If the wings of the army be supported by rivers, the fords must be destroyed*, and these wings covered by banks of earth furnished with heavy artillery to drive off any batteries of the enemy that may assail the rear of the position. If the wings rest upon woods, we must cover them with abattis, sustained by redoubts, batteries, &c. If there be villages on the front, and even in the rear of the position,

* To destroy a ford, deepen the river by excavations, or lay abattis, chevaux de frise, harrows, stones, &c. in the stream. Trous de loup or war pits may likewise be made in the bed of the river.—*See Teilke on Field Fortification.* TRANSLATOR.

they must be intrenched and occupied. If any commanding height be within gun-shot of the position, it must be occupied and intrenched. Finally; care must be taken of the communications in retreat, and to cover the fixed batteries by epaulments that protect the pieces without restraining the fire.

Consequences.

This simple exposition shows, that an army on the defensive must daily wield the spade and the pick-axe; they are the lever by which the momentum of the resisting force is increased.

The particular disposition of works on the points of fortified positions.

The proper disposition of works on the different points of a position, is of the greatest importance in war, and has so powerful an influence on the success of an action, that a work badly placed is frequently of more injury than use. The disposition of works belongs to the *coup d'œil* of the engineer; he should discover instantly the properties of the ground under all the relations of attack and defence, and in like manner calculate the new properties that it will possess when he has modified it by works of fortification.

Reconnaissances in relation to fortification.

It follows from the preceding considerations, that no field work of fortification ought to be established but after a *reconnaissance* that proves the necessity of it. By this reconnaissance the general form of the ground is determined; likewise its nature, and all the variations and details that exhibit themselves under an infinity of forms. When this graphical description is properly made, and the nature of the materials to be found on the different points of the site, are known, we possess all the data requisite to form the general projection of the works and of the elements that are to enter into the composition of the general system.

Reflection.

The exposition of the military events cited in the First Part, render these general truths so palpable, that it would be useless to further descant upon them. At Turckheim, a commanding height, which the enemy had neglected to seize, gave victory to Turenne. At Malplaquet the general and particular defensive dispositions were very vicious; for instance, they neglected to intrench the farm in advance of the French centre. We have seen with what skill Turenne and Montècuculi each day intrenched themselves during the immortal campaign of 1675.

CHAPTER II.

Regular Field Fortification; the Principles that determine the form of Intrenchments; Profiles; the horizontal Projection; Systems of Continuous Lines; Lines with Intervals.

70 Method to be followed in treating the theory of field fortification; the hypothesis for the form of the ground.

70. TO proceed methodically in unfolding the theory of field fortification, we will suppose the ground to be of a certain form; this will greatly simplify the subject, and lead us from the simple to the complex, and to principles and results that may be considered as formulæ or rules applicable to all particular cases. This is the order that we have followed in our investigations of the principles of grand tactics. Accordingly the ground upon which the fortification is to be traced, must be supposed an horizontal plane, the same as the horizontal plane of projection. We will then consider separately each kind of work and describe its form, construction, and armament; and their assemblage will form those elements that may be used separately or in systems more or less complex and regular.

Regular fortification.

A *regular fortification*, is a work situated upon an horizontal site; but its form may infinitely vary, according to the genius of the engineer.

71. Definitions: 1st Of a work of fortification

71. All obstacles constructed to protect, preserve, or increase the strength of other arms, are called *works of fortification.*

2d. Of intrenchment.

All isolated parts of temporary and even permanent fortification, are called *intrenchments.*

2d. Of a body of troops intrenched.

Troops posted behind an obstacle that the enemy must overcome before he can come in contact with them, are said to be *intrenched.*

Intrenchments are distinguished into natural and artificial. The first are formed by nature on military sites, and consist of water courses, woods, marshes, ravines, &c. The latter comprehend all the various works of fortification that are constructed on the different points of sites with the materials at hand.

The materials and implements used in the construction of intrenchments.

The materials used in war by the fortifying officer to construct intrenchments, are such as nature abundantly produces on the spot, and consist in, *earth*, *stone*, *waters*, *turf*, *fascines*,

and woods of all kinds. These are universally scattered over the surface of the globe; and the fortifying officer ought to be acquainted with their nature and qualities, to be able to use them to the greatest advantage.

The implements of temporary fortification are, the shovel and the spade, the mattock and the axe, and other utensils for breaking and digging the earth. These are in ample quantities attached to the engineer park, as well as other instruments used in nice work by the artificers belonging to the companies of sappers and miners.

72. Principles that govern the general form of an intrenchment.

72. The principles, according to which the general form of an intrenchment is determined, are deduced from the purpose of the fortification and from military facts dependent thereon.

Purpose of intrenchments.

The purpose of an intrenchment is to arrest the march of an attacking foe, by presenting obstacles before him to be surmounted that impede an immediate attack, partly shelter the defending troops from the missive weapons of the assailants, and afford time to the former to destroy great numbers of the latter with their missiles before the corps come in contact.

1st *Principle.*

Consequence.

Hence it follows, that the numerical and positive forces of the assailed may be much less than those of the assailant, and yet an equilibrium exist; and that the value of the intrenchments will be as much above, as the ratio of the two forces is less than unity. Accordingly all intrenchments are to place troops, weak in numbers and other defensive means, in a situation to give battle and defend a position with advantage against a more numerous enemy moving to attack by main force. It follows also, that the form of the intrenchment should be such as to cover as much as possible the defenders and the means of defence; that the assailants should not be able to scale them without great difficulty; and that during the action the assailed have room for the full use of his missive and wielded weapons.

Means used for the defence of intrenchments: facts established by experience.

Intrenchments are defended; 1st, by the fire of artillery, striking at great distances; 2d, by the fire of musketry, the effect of which is nearer and more certain; 3d, by the naked weapons (*les armes blanches*), which come into action the moment that the enemy is in contact with the defending party, after braving all the fires and overcoming all obstacles.

First fact relative to the range of artillery, and of the musket.

We have given (art. 50) the mean ranges of artillery; we will merely call to recollection that the range of the musket is

2d *Principle.*

fixed at 200 to 240 mètres (222 to 266 yards); beyond this latter limit there is no certainty of execution.

Second fact, respecting the mean height at which the soldier holds his musket in firing. (See St Paul's work); in fortification this height should be fixed at 135 to 140 centimètres.

The second fact which we should examine with care, is the vertical height at which a soldier of common stature holds his musket in firing under any inclination. The measure of this height is of the greatest importance in fortification; many writers have fallen into great errors in determining it. This measure must not be used in fortification as it is established by minute tactics; it must be diminished for two reasons; 1st, because a soldier behind an intrenchment inclines a little forward in firing; 2d, because he fires beneath the horizontal when the enemy approach very near to the intrenchment. This height was fixed formerly at 4 feet 6 inches (4 feet 10 inches English), but this quantity is too great; we shall reduce it to between the two limits of 135 to 140 centimètres (4 feet 6 inches, to 4 feet 8 inches English); the variation between these two limits being necessary, according to the greater or less inclination under which the soldier is to fire.

3d *Principle.*

Third fact respecting the natural direction of the line of fire, perpendicular to the intrenchment.

Observation has convinced tacticians and engineers, that when a soldier in firing is guided alone by his natural impulse, he presents his musket perpendicular to the line or front of the intrenchment; so that the horizontal projection of the *natural line of fire*, is always perpendicular to the direction of the front of the troops or intrenchment. It is in vain that the officers of the line endeavour to oblique the fires; they cannot effect it, especially in the tumult of battle or night attack.

4th *Principle.*

Consequences, and very important rule relative to the direction of musketry fire.

It results from this fact, established by observation, that the horizontal projection of the lines of fire is known, when that of the direction of the intrenchment is also known; for the first must make with the latter nearly a right angle, or an angle never exceeding 100 degrees.

Fourth fact: the position in relation to the horizontal, of lines of fire of musketry and artillery.

Experience has shown that the inclination of the line of fire of musketry never can be more than 12 to 15 degrees beneath the horizontal; beyond this, the soldier fears to too much expose himself; and it is with great difficulty that he is brought to fire under a greater inclination. The same observation is true with respect to the fire of artillery; the line of fire cannot be inclined more than 10 degrees below the horizontal; a greater inclination would destroy the carriage. With heavy calibers* the inclination does not exceed $\frac{1}{6}$ of the horizontal line.

5th *Principle.*

* That is, an angle whose tangent is one sixth. TRANSLATOR.

Such are the general principles that must guide us in determining the form of intrenchments.

73. Graphical delineation of the primitive or generating profile of a field work.

73. The form of intrenchments is so simple, that it only requires a knowledge of two things to draw the graphical delineation; 1st, the primitive or generating profile; 2d, the figure of the horizontal projection of the directrix* on which the profile must move at right angles with the front to generate the intrenchment.

The *primitive profile* means the projection of the intrenchment on a plane vertical and rectangular to its direction. It is obvious that the figure of this profile, and of the horizontal directrix, should be determined according to the rules prescribed by attack and defence and the principles established in the preceding article: we will now consider the construction of the primitive profile.

The ditch, and its profile: bounded by the lines of the scarp, and counterscarp. (PLATE XI, fig. 1.)

Of all obstacles that can be interposed between the assailant and the assailed, and the easiest to be conceived and executed with despatch is evidently the *ditch* (*le fossé*), of greater or less width and depth. For, if after having traced upon the vertical plane of projection the ground line $T'T'$, we draw the two equal perpendiculars ab and cd, we have the profile of the ditch; the line ab is the profile of the counterscarp, and cd is that of the scarp. It is equally natural and simple to make use of the earth thrown up in excavating the ditch, for the purpose of forming on the side of the defence an embankment of sufficient height to cover them from the sight of the assailant, and sufficiently thick to arrest the flight of projectiles. This covering bank is called the *parapet*, and is of another great advantage, as it increases the height of the scarp more than two mètres ($2\frac{2}{9}$ yards). The least height of a parapet should be 220 centimètres ($7\frac{1}{3}$ feet), which is that of a man on horseback; this height is sometimes as great as 300 and even 400 centimètres (10 to $13\frac{1}{2}$ feet).

The covering embankment or parapet: its height and thickness.

The thickness of the parapet is proportioned according to the kind of projectiles with which it is exposed to be battered, and is determined by experiments showing the mean depth to which balls penetrate in well rammed earth. These depths in made and rammed ground, vary according to the tenacity and density

Depths to which shot penetrate in made and rammed earth: mean thickness at the summit of a parapet.

* The *directrix*—The diregent, or line of motion in the generation of any plane or solid figure. TRANSLATOR.

of the earth. For common earths we may adopt the following results, and by them determine the thickness at the summit of the parapet, according to the probability of its being attacked by infantry only, or by both artillery and infantry.

Caliber.	Depth penetrated.			Thickness of parapet.		
	feet.	in	(Eng.)	decim.		(Eng.)
Musket ball	35 cen. or	1	2	6 *a* 10	or 2 to $3\frac{1}{3}$	feet
4 pound shot	125 ...	4	3	20 *a* 25	$6\frac{2}{3}$ to $8\frac{1}{2}$	..
8 pound shot	200 ...	6	9	30	10	feet
12 p'd shot	370 ...	12	5	40	13 ..	5 in.
Shot of heavy calibers	400 ...	13	5	60	20 ..	0 ..

Profile of the parapet and relief of the work: the terre plein and banquette next behind the parapet: and the breast height.

If now we draw the two verticals *cf*, *kg* above the ground line, distant the thickness of the parapet and 220 to 300 centimètres ($7\frac{1}{3}$ to 10 feet) in height, we have the profile of the parapet; and the line *df* will be the height of the scarp or the *relief of the work.*

The inside part *k T'* of the intrenchment, is called the *terre-plein;* it is covered and protected from the view and fire of the enemy. Without some modification the troops destined for the defence of the intrenchment would be unable to use their missive weapons, and the work would be worse than useless. This modification is effected by constructing behind the parapet a mound called a *banquette*, upon which the soldier mounts to look and fire over the parapet. The height of the banquette must be so determined that the line *gm* called the *breast height* (*hauteur d'appui*) shall be, as we have already said, 140 centimètres (4 feet 8 inches). The breadth of the *banquette* is from 10 to 14 decimètres ($3\frac{1}{3}$ feet to $4\frac{2}{3}$ feet), with a slope (*talus*) *no* double the height *mk*.

Superior slope of the parapet.

If the superior surface *gf* were horizontal, the line of fire would not strike the enemy after he had gotten within point blank. In order therefore that the fire may be effective even to the edge of the counterscarp, the two points *a* and *g* are joined; and the line *gq* is the superior slope or plunge (*plongée*) of the parapet; unmasking all the ground over which the enemy must pass. When according to this construction the slope is too great and the angle *g* too acute, it is diminished by

making it pass through the point p, elevated 10 decimètres ($3\frac{1}{3}$ feet) above the point a; and then the slope is gq'.

Banquette for artillery called *barbette*; and the breast height, called *genouillere* (PLATE XI, fig. 1.)

The banquette for musketry, is not fit for artillery; this arm requires a special kind of banquette in those parts that it is to occupy. The bore of field pieces being raised about 110 centimètres ($3\frac{3}{3}$ feet) above the plane upon which the carriage moves, it follows that the banquette for artillery, which is designated by the name of *barbette*, should have a greater elevation than the common banquette; and that the *breast height*, in this case called the *Genouillère*, should not exceed 90 to 100 centimètres (3 feet to $3\frac{1}{3}$ feet) at farthest. Thus the height of the genouillère gr=90 to 100 centimètres; and the breadth rs of the barbette, should be 40 to 50 decimètres ($13\frac{1}{2}$ to $16\frac{3}{4}$ feet) for the recoil and manœuvring of the piece. The length of barbettes is in the proportion of 30 to 40 decimètres (10 to $13\frac{1}{2}$ feet) for each piece of artillery.

Properties of this profile.

The profile that we have now constructed, possesses in the highest degrce advantages for the defending party: 1st. It presents the greatest obstacle, being terminated exteriorly by vertical planes. 2d. It covers the persons and manœuvres of the assailed. 3d. And it gives full scope to their missive weapons, even to the edge of the ditch. Accordingly, if we could in practice model our works after this profile, the proportions of which might be varied without varying the figure, field intrenchments would, as respects the profile, be perfect. But the nature and qualities of the first strata of the earth's surface, are very far from affording these advantages. In the construction of intrenchments we meet, 1st. Rocks of great hardness, which must be cut perhaps entirely with the pick-axe; in this case, the work is very difficult and slow, and we are frequently obliged to abandon the attempt to hollow out a ditch in these hard masses; 2d. Loam, clay, gravel, &c.; these substances are composed of integral particles of no great tenacity, and may be easily excavated; but it is impossible to dig perpendicularly in these kinds of earth; 3d. A stratum of loose earth, light and easily broken and worked: Finally, we meet all kinds of sands, more or less light, and whose particles are little adhesive; they are easily worked; but works constructed of them are neither solid nor strong. In examining the nature of these substances under the relation of the adhesion and mobility of their integral particles, we perceive that

Qualities of the materials used for constructing intrenchments.

Law of nature relative to the slopes required by different bodies.

they are comprised between the two classes, very hard bodies, and fluid bodies; with these we are well acquainted, as respects the properties under consideration. The first may be cut perpendicularly, and preserve this form; whilst the latter can only be kept steady in an horizontal state. Hence it follows, that intermediate bodies cannot remain steady without support, except by assuming intermediate positions between the vertical and horizontal. Rock sustains itself perpendicularly. Loam, clay, and several kinds of gravel, require slopes of $\frac{1}{4}$ or $\frac{1}{3}$ the vertical height. Fresh earth is sustained by a slope of $\frac{1}{2}$, $\frac{2}{3}$, or $\frac{3}{4}$ of the vertical; made earth may be sloped under an angle of 45 degrees; and sand, which is the nearest to a fluid body, requires various slopes, sometimes as great as thrice the vertical height.

Consequence.

Since the laws of slopes are established by theory, and confirmed by experience, the engineer must form his profile accordingly; under pain of seeing his works destroyed by the single power of gravity. He should study carefully the properties of the materials afforded by nature on each particular site, before he establishes the primitive profiles whose scarp and counterscarp must be as near as possible to the vertical; guided however always by the doctrine of slopes, and the degree required by the kinds of earth used in the construction.

Modifications that the laws of slopes subject the primitive profile to (PLATE XI, fig. 4)

Let us now suppose that we must modify the primitive profile accordingly, in order to apply it to ground composed of common new earth, requiring a slope of $\frac{1}{3}$ the vertical height. The counterscarp *ab*, must be sloped to the $\frac{2}{3}$; but the scarp *cd* cannot have this slope, because it has to support the pressure of the weight of the parapet; therefore its slope should be 45 degrees. This same consideration, and the difficulty of uniting in one line the foot of the exterior slope of the parapet with the side of the scarp, obliges us to leave a moulding (*bande*) *cc'* of natural ground 5 to 10 dicimètres (20 to 40 inches) wide, called the *Berme*. The exterior slope of the parapet is formed of earth falling under an angle of 45 degrees. Lastly, as the breast height must not be sloped more than 4 to 5 decimètres (16 to 20 inches), it is constructed of special materials, such as fascines, or sods, &c. The *genouillère* is made with still more care, and often with *saucissons*. These rules being established, it is obvious that for every particular case it will be easy to draw the plan of each separate profile.

The berme left on the side of the scarp.

Let us place the point g, the vertical projection of the interior crest of the parapet, upon the perpendicular gK; make Kc' equal to Ky the thickness of the parapet at the summit, added to the quantity cq (fig. 1); through c' draw the slope $c'Z$, cut in q by the plunge ga; make mx equal to 4 or 5 decimètres (16 to 20 inches), this will give the breast height gx, &c.: then let $c'c$ equal the breadth of the *Berme*; and draw the scarp cd and counterscarp ab, agreeably to the slope they should have.

The interior crest of the parapet, called the covering line, or line of fire

Of all the parts of the profile, the interior crest of the parapet is the most important; for by the position of this line the assailed party are covered; hence it is called the *covering line*. It is over this that the fires take place, and by it the quantity of fire is calculated; hence it is often called the *line of fire*. It is by this line that we judge of the extent, capaciousness, and figure of works; and it should be considered as the directrix of the horizontal ground plan.

Of the glacis in advance of the counterscarp.

An addition is frequently made to the profile of a small glacis aVp' in front of the counterscarp, that increases the labour, but also increases the strength of the intrenchment. This addition should only be made when the height gK is such, that the enemy at p' cannot overlook the point g, and thus obtain a plunging fire into the parapet. To trace the glacis, we make aV equal to 10 or 12 mètres (11 to 13½ yards) and protract the line of fire gV bounding the glacis; then make the slope $p'a$, or $p''a'$ when it is intended to have a kind of berme aa' of about 2 to 3 mètres (6⅔ to 10 feet) between the counterscarp and the glacis.

Connected nomenclature of all the parts of the primitive profile.

We will now recapitulate the names of the several parts of the original profile, in the order that they are placed; proceeding from the outside to the interior of the work we have: 1st, the glacis and its reverse: 2d, the counterscarp: 3d, the scarp: 4th, the berme: 5th, the exterior slope of the parapet: 6th, the plunge or superior slope of the parapet: 7th, the covering line: 8th, the breast height: 9th, the banquette and its slope: 10th, the terra-plain or natural ground or area.

74. Several kinds of profiles. (PLATE XI. fig 2, 3, 4, and 5.)

74. As the original profile is ever the result of the plans of the engineer, necessarily modified by and subjected to certain rules and conditions, there must of course be various kinds of profiles admitted under different circumstances. Sometimes it is intended to only oppose slight obstacles, and to construct a

work in a few hours. Sometimes it is intended that the work shall be pretty strong and defensible, but at the same time speedily executed. At others, it is designed that it should possess all the properties required for defence. And finally, there are cases when neither labour nor time are to be spared, and the intrenchments are to have greater elevation or *relief* and command over the adjacent country.

Plate XI shows the series of four kinds of profiles, respectively increasing in strength. The *first* is to cover grand guards established in advance of the colour line of camps, &c.; they are without ditches, and formed of earth thrown up from the interior. The *second* is for works hastily constructed, even under fire of the enemy; part of the earth is taken from a slight ditch, and part from the interior; the banquette is established upon the natural ground. The *third* is the complete profile, which we have already described. Lastly, the *fourth* is for works of importance, such as small forts, têtes de ponts, &c. This last kind has a rampart that increases the relief and commanding properties of the work. The têtes de ponts of Cassel, Neuwied, &c. on the Rhine, were constructed on similar profiles.

75. The two dimensions of the ditch : the earth thrown out of the ditch.

75. The two dimensions of the ditch are yet undetermined; because they not only depend upon the rules of defence and the plan for executing the work, but as the excavation or earth thrown out of the ditch is to furnish the mass or quantity for the embankments, which is known by the formation of the profile, this equalization cannot be established until we know the horizontal projection of the directrix. As we will investigate this hereafter, let us suppose this projection to be traced; likewise the paths passed over by the centres of gravity of the ditch and profile: let F and P be the respective measures of these two projections; A^2 the surface of the profile, and x and y the two dimensions of the ditch; then we have the equation $F x y = P A^2$, from which one of the unknown quantities being given, the other is deduced.

On the position of the centre of gravity of the section of the ditch.

By supposing the position of the centre of gravity of the section of the ditch to be nearly known, the error is very trifling, and may be corrected by a second operation.

Local circumstances, the maxims of defence, and the figure of the horizontal projection of the intrenchment, all influence the engineer in determining either dimension of the ditch. In

any case the width should not be less than 30 decimètres (10 feet), nor the depth less than 20 decimètres ($6\frac{3}{4}$ feet.). When the ditch can be filled with water, its depth should be such as to allow 20 decimètres for the depth of the water. When ditches are overlooked and flanked, it is better to increase their width and lessen their depth; but when we cannot fire upon the enemy in the ditch, and he may there form, then the depth must be increased and the width diminished. On this subject, we refer to those authors who have treated it with attention, and particularly to the writings of Cessac and St. Paul.

(See Clairac, Cessac, Foissac, and St. Paul.)

76. Having formed some idea of the *relief* or vertical projection of field fortification, by the composition and delineation of the primitive profiles; it remains for us to consider the horizontal projection, or the figure of the *line of the directrix* on the horizontal plane, which is supposed to be the same as the site of the work.

76. Form of intrenchments on a plane, or horizontal projection. (See Clairac, Cessac, Foissac, and St. Paul.)

The works used in field intrenchments are divided into two classes, each comprising many species. Their choice depends upon the object to be attained by the fortification, and on the position to which it is adapted (art. 67). The *first* class comprehends works of extended fronts of greater or less length, and the flanks and rear of which are only covered by natural obstacles or dispositions of troops. This class of works has the generical appellation of *lines;* they are constructed on the fronts of camps, on the assailable points of positions, and in the organization of the defences of frontiers.

Distinction of works, enclosed and isolated: and *lines.*

The *second class* comprises all works enclosed throughout their whole circumference, and which may be used separately, or in extended systems by combining them together They consist of *redans, flêches, lunettes, redoubts, têtes de ponts, small forts. field forts, &c.* 'Tis after studying these latter works, that we advance by insensible degrees to those important principles that lead to the more complicated study of the fortification of fortresses.

77. The term *system*, has been used to designate the different figures given to the directrix, and with the principal of which we propose to make the student acquainted.

77 The systems of field fortification or lines

The most simple figure that can be given to an extended intrenchment, is that of a right line; and it is executed with the least labour and expense.

First system the right line

Analysis, according to the direction of the fires of the intrenchments.

The analysis of this system shows its defects for defence ; for according to the principles established (72), the horizontal projections of the lines of fire, are perpendicular to the covering line ; consequently the approaches to the intrenchment will be only swept by direct fires ; and as all the parts oppose one uniform resistance, they may be considered as isolated, for they do not reciprocally protect each other, and there does not exist between them any defensive relations.

78 Investigation of principles to determine the figure of fortified lines.

78. To discover what figure of lines affords a greater resistance than a right line, we must, in addition to the definition of a work of fortification, take into view a few principles of tactics on the value of musketry fire directed against attacking columns ; and thence deduce some general principles embracing the properties that a *fortified line* should possess in order to fulfil the object of the defending party.

We repeat, that a work of fortification is a particular field of battle, prepared before hand, and in which a body of troops may fight with advantage against a very superior attacking enemy. An intrenched position is also a great prepared field of battle, in which an army may defend itself, and even fight with advantage against a very superior foe.

Fires distinguished into *direct, flank and cross,* and *reverse* fires. (See arts. 52 and 35.)

We must apply to musketry what we have said with respect to the kinds and value of artillery fires ; paying attention to the direction (52) and the intrinsic value of musketry fires (35). Accordingly we will distinguish in their horizontal projection ; 1st. The *direct fires*, which are of least effect, for they only strike the front of the enemy ; 2d. *Flank* and *cross fires*, of greater effect than the former, because they strike the flanks of the attacking columns, which with difficulty sustain themselves against them ; and combine their effects with the direct, to produce cross fires, the great effect of which all experience proves ; 3dly. *Reverse fires*, which are better than the former kinds, for the enemy can neither defend himself against, nor return them.

Flanked dispositions.

It follows from these facts and the position of the line of fire on the directrix, that it is susceptible of such a configuration, that the ground over which the enemy's columns must pass, shall be swept by flank, cross, and reverse fires. This is called a *flanked disposition.* This general arrangement has ever appeared so essential, that strictly the term *fortified lines*, has only been applied to those whose parts mutually support and flank each other within good musket range.

From the preceding considerations, we deduce the following general principles:

First principle respecting flanking

1st. All the parts of a fortified line should reciprocally protect and flank each other within good musket range, established at 250 mètres (278 yards). The *angle* of *defence*, is the re-entering angle formed by two lines that flank each other.

The angle of defence.

2d Principle respecting the angle of defence.

2d. The angles of defence should never be acute, and should never fall beyond the limits of 90 to 100 degrees. When the angle of defence is acute and less than a right angle, the fires of the flanking part strike the flanked part, and are liable to annoy the troops on the defence. If this angle be too great, there will be a space in front of the counterscarp that will be totally destitute of any kind of fire.

Salient angles.

The salient angles that form part of the *tracé* (ground plan) of a line, should be of sufficient magnitude to allow the manœuvring of the cannon and troops; besides proper solidity in the construction, requires that these angles be not too acute.

3d Principle respecting the measure of the salient angle

3d. The salient angles should not be less than 60 degrees.

4th Principle of the defence by the sword and bayonet.

4th. The ground of the intrenchments should be properly prepared for the manœuvres of defence or retreat. As the third means of defence are the bayonets of the infantry and the swords of the cavalry, we perceive the importance of properly disposing the ground in rear of the intrenchments, in order that the manœuvres may be performed without restraint; the case of a forced retreat should also be provided for.

Secondary intrenchments, or redoubts in rear, to sustain the courage and confidence of the troops, and cover a retreat.

It is a settled principle and founded on experience, that a defence can only be vigorous and obstinate in proportion as the troops are convinced of their means of rallying in rear, or retreating with safety. This shows that we must construct in rear of the intrenchments, or inside the terre-plein, enclosed works, secondary dispositions, and redoubts, that will afford this necessary assurance to the troops.

5th Principle of secondary dispositions, to cover the rallying, or retreat.

5th. Secondary intrenchments must be made behind the principal intrenchments, and redoubts inside the enclosed works; to secure offensive returns, cover the rallying of the troops or a retreat, or secure an honourable capitulation.

6th. Principle of the relation or ratio that should exist between the extent of the front, and the numerical forces of the defendants

6th. Lastly, we will establish this principle: that the display or extent of the front, and the numerical force of the defending troops, should be in such ratio to each other as is prescribed by the rules of defence dependent on minute tactics.

Calculation of oblique fires.

Oblique fires over the covering line are not calculated by

this line, but by the perpendicular included between the extreme lines of fire.

79. System of angular lines.

79. By applying the preceding principles to discover the general figure of lines, we see at once that their figure should be angular; opposing to the enemy salient angles with re-entering parts. By this general form, we obtain two great advantages: first, we have cross and flank fires; second, many parts are re-entering and less assailable, by reason of the quantities of flank, cross, and reverse fires that defend the approaches to them.

Elements composing the tracé of angular lines.

There are four kinds of elements or figures used in the *tracé* (ground plan) of flanked and angular lines; the *straight line*, the *redan*, the *bastion*, and the *mitre* or *priest's cap* (*bonnêt de prêtre*) or swallow's tail (*queue d'hironde*).

The redan, considered as the element of the angular systems: its properties and defects: its common dimensions. (PLATE XI, fig. 6.)

Any salient figure opposing a point towards the enemy, is called a *redan*, and is composed of a flanked angle, two faces, and a gorge or line connecting the extremities of the two faces: the line *mn* which cuts the salient angle into two equal parts, is called the *capital*. The chief property of the redan, is the substitution in lieu of the direct fire of the gorge *BC*, two columns of flank fires *ABge* and *ACdf*: but there is on the capital *mn*, a sector *eAd* totally undefended by fire; this sector is great in proportion as the angle is acute, and small in proportion as the angle is great. The tracé of the common redan is made by allowing about 30 mètres (33 yards) for each demi-gorge, and 44 mètres (49 yards) for the capital; this will make the faces 53 mètres (59 yards), and the flanked angle about 66 degrees.

The bastion. (Fig. 7)

The *bastion* is a large redan *MAP*, the faces of which are broken (*brisès*) at about $\frac{2}{3}$ of their length, to form the flanks *CE* and *BD* which have peculiar properties. The angles *C* and *B* are called the *shoulder* angles (*les angles d'epaule*). This figure gives four columns of fire, *FB*, *GC*, *oD* and *NE*; but it has also three sectors of a circle before the three angles *A*, *B*, and *C*, destitute of fire. The tracé of this figure in every case, is made by allowing 60 to 70 mètres (67 to 79 yards) for the faces, and 35 to 40 mètres (39 to 45 yards) for the flanks; the flanked angle must always exceed 60 degrees.

The bonnet de pretre or priest's cap (Fig. 8)

The *priest's cap* (*bonnet de prêtre*) or mitre, is a large work likewise derived from the redan, with a gorge of about 150 mètres (163 yards), and the faces of which are terminated

about 100 mètres (111 yards) from the gorge by the parallel front *CE*. From the front, the quantity *MD* is taken upon the capital, so that on drawing the lines *CD* and *ED*, the angle of defence *CDE* is about 100 degrees.

The *flêche* (arrow) is nothing more than a small detached and isolated redan, that is used in the dispositions of lines and other systems for a particular purpose. The flèche.

The *lunette* (small half moon) is a small detached isolated bastion, which, like the *flêche*, is used in systems for certain purposes. The lunette.

Since the period that the Princes of Orange and Nassau revived the true principles of war, it has been customary in planning field intrenchments to break the straight line into redans, supported by small forts placed at proper distances. In the time of Turenne, Condè, Montècuculi, &c. this method was constantly observed, and Marshal Vauban only added more simplicity and regularity to the tracing of lines; for long before the time of this celebrated engineer, redans and small forts were used in the construction of intrenchments. Vauban, in this respect, did not improve fortification; for the only tracé of redans that he used, is full of errors and defects.

First angular system. Lines with redans and straight curtains. (PLATE XI, fig. 9.)

The tracé of the line with redans and straight curtains (*courtines*), consists in describing on the right line at proper distances from each other, redans *A* and *B* which intercept its direction; the straight lines that connect the redans, are called *curtains*. In this tracé the faces of the redans afford columns of flank fires crossing those of the curtains, and each other; their fire also crosses the capitals of the adjacent redans. Vauban placed his redans 240 mètres (268 yards) distant apart from capital to capital.

Examination of this system

The line *ad*, drawn from the salient angle to the angle made by the face of the redan and curtain, is called the *line of defence*. This line in the old system is about 220 mètres (245 yards), and the angle of defence exceeds 113 degrees. To at once examine this system and discover its advantages and defects, we need only draw from the curtain and the faces of the adjoining redans, the extreme lines of fire, *Cq*, *dl*, *dh*, for the redan *B*; and *aq*, *bq'*, *br*, for the redan *A*.

Its properties.

Its obvious properties, are; 1st, there is in front of the curtain a triple cross fire, making this re-entering part the strongest: this will induce the columns of attack to direct themselves

against the capitals of the redans; nevertheless it must be observed, that on the inner side of the extreme lines of fire there is a triangular space *bkd*, of which the curtain is the base, that is only swept by direct fires: 2d, that the lines of fire of the redans cross on the capitals, but at a distance of 96 mètres (108 yards) from the salient angle: 3d, that all the parts flank each other.

Its defects.

The defects of this system are very great; 1st, the dimensions of the redans and the arc measuring the salient angle, are too small; whence it follows, that the columns of flank fires are very narrow, that the projection of the redans beyond the curtain is too little, and that the manœuvres of the artillery and infantry in the redans are very confined: 2d, the redans are too far apart; this leaves a mean space of about 80 mètres (90 yards) in front of the salient angle that is not defended by either flank or direct fires, because the angle of defence exceeds 100 degrees: 3d, the lines of defence are too long, and the fire is not effectual upon the capitals; this is the most important defect: 4th, no part of the ditch is flanked or overlooked. It follows from these defects, that the columns of attack by moving with small fronts against the capitals, will sustain no injury from the fire 'till they arrive at the intersection of the capital with the line of fire from the summits of the salient angles; in passing this boundary they enter upon the space swept by the flank fires, to which they cease to be exposed on approaching the counterscarp; this they may gain without danger, and descend into the ditch, which is quite below the plane of fire and totally undefended.

Consequences in an attack.

Deduction respecting the value of this system

We must conclude, that the old system of lines with redans is not founded on correct principles, and should not be employed without being corrected and divested of its principal defects. It is astonishing that Vauban should have constantly used it, without perceiving the weakness that is inherent in the arrangement of all its parts.

Correction of this method, by merely bringing the redans nearer. (Fig. 9)

The engineers who constructed field works after Vauban, soon perceived the necessity of correcting the tracé of the line with redans; they brought the redans nearer to each other, placing the capitals 180 mètres (200 yards) apart. By this simple alteration the system became much stronger. Accordingly, by moving the redan *A* to *E*, we find: 1st, that the angle of defence is a little reduced, being about 108 degrees; 2d,

that the mean portion of the capital destitute of fire, does not now exceed 40 mètres (45 yards): 3d, that the lines of fire cross each other with effect upon the capitals. Yet it has still great defects: 1st, the enemy may gain without danger the salient parts, whose faces are not scoured by any fires; 2d, the ditches are not defended; 3d, the inside of the redan is too confined; 4th, the re-entering formed by the curtain, is not sufficiently great or retired.

Subsequent corrections of this method, by increasing the dimensions of the redans. (Fig. 10)

To construct a system of redans more perfect than the preceding, we may follow the tracé of fig. 10, in which the redans are 160 mètres (178 yards) apart, from capital to capital, and their dimensions are increased. The demi-gorges are 40 mètres (45 yards), the capital 55 (62 yards), and the salient angle about 70 degrees. If now from the summits of the salient angles we draw the perpendiculars *af* and *dc* to the faces of the redans, and draw the curtain *cf*, we have the system *acfd* which has fewer defects than the preceding: 1st, the parts *fe*, *bc*, of the faces, will furnish good cross fires on the parts *av* of the capitals that were before undefended; and by slightly obliquing the fires, they will take part of the salient in reverse; 2d, the interior of the redan is larger and more favourable for the necessary manœuvres; and the redoubts *R* may be constructed in them; 3d, the curtain and the re-entering are more retired; but the faces of the redans and the ditches, are still without defence. To remove these defects, modify or break the curtain towards the exterior into the form of the redan *ctf*, the fire of which will take in flank the approaches to the faces, and scour the advanced part of the ditches *axy*: *xy* being the intersection of the plunge of the parapet with the bottom of the ditch.

Rounding of the salient angle, or forming a *pan coupé*.

As every salient angle produces a sector on the capital destitute of direct fires, the covering line is rounded by a curve tangential to the two faces, or a flat front (*pan coupé*) is given to the angle. This enables us to post in the salient angle 10 or 12 infantry, or to advantageously occupy it with pieces of artillery; one of which, stationed on the capital, will sweep the attacking column from front to rear.

Second system: lines with redans, and curtains thrown forward or swallow-tailed (PLATE XI, fig. II)

In the system of redans with curtains thrown forward, the redans are not in defensive relation so far as regards musketry; but they are defended by the branches of the broken curtain. Consequently we may place the capitals as much as 300 mè-



tres (335 yards) distant from each other. In this case the line of fire *dg* from the middle of the half curtain, will not exceed 200 mètres (222 yards). The distance from the gorge line to the front line, should be about 60 mètres (68 yards), so that the angle of defence *abd* will not exceed 100 degrees.

Third system: Lines with tenailles. (Fig. 12)

The system of great tenailles is traced between two fronts distant about 70 mètres (78 yards), and is composed of large and nearly right angled redans, so connected together that the angle of defence *abc* does not exceed 100 degrees, and the extreme line of fire *ag* is not greater than 320 mètres (356 yards).

Examination of the 2d and 3d systems.

There is great analogy between the system of swallow-tails (*queue d'hironde*), and of great tenailles; the latter is only a slight modification of the former, and they both have nearly the same advantages and defects: 1st. in both methods the approaches to the counterscarp and the capitals are scoured by flank and cross fires that take effect to the very edge of the counterscarp; but here the second method is more perfect than the first: 2d, the parts of the ditch in front of the salient angles are flanked, and more so in the method of tenailles, than in the other. If we examine the defects, we will find; 1st, that the enemy may easily batter in ricochet all the faces and parts of either method, and that this defect is greater in the tenaille, than in the other; 2d, that great part of the ditch is undefended; 3d, that both methods present many assailable salient points; and that on a line of 600 mètres (670 yards) the method of swallow-tails presents *five*, whilst the second only offers *three;* 4th, that they both are very defective in not having the re-entering parts sufficiently retired; for these are really not much less assailable than the salient parts.

Conclusion with respect to the value of these systems.

These methods do not seem to deserve much confidence, and are inferior in strength to the method of the redans, corrected as we have explained.

Fourth method. Lines in cremaillères. (Fig. 13.)

Lines *in cremaillère* (serrated) approach much nearer to the right line, in the place of which they are substituted with great advantage under many circumstances. They are drawn between two front lines distant apart only 25 to 30 mètres (28 to 33 yards), and on which the capitals are placed distant from each other about 110 mètres (123 yards); the outer points are connected with the inner by very oblique lines, which form the branches of the cremaillères and have the same direction as the flank fires that are to be obtained. Then from the outer points perpendiculars

are drawn to the inner branches and form the *crotchets*, whose fires flank the approaches of the counterscarp and part of the ditch of the branch.

Examination of this method.

It is plain that this method is superior to that of the right line; for from the distance of the capitals and disposition of the crotchets, the approaches are in every part flanked, and the counterscarp scoured, by a column of fire more than 60 mètres (68 yards) in depth; and as the plane of fire from the crotchet sweeps the bottom of the ditch of the next branch at a given distance ax from the salient, this part of the ditch is defended. But this method, like that of the right line, has the defect of having no re-entering parts, and of being equally assailable at all points. It has also the defect common to all the other methods with long branches, of exposing to ricochet fires long parallel lines that may be easily enfiladed and taken in reverse.

Use of this method.

This method may be used with advantage when it is necessary to intrench very near the bank of a stream or edge of a declivity, and particularly in cases where the ground slopes from the tops of hills down into valleys; this is a case in irregular fortification, that precludes the enemy from seizing the prolongations of the branches: finally, it may be used in the arrangement of the tracé of complex lines.

Observations on the defence of the ditches, and on the dead angles.

In all the systems whose horizontal projections we have described, we observe one common defect,—That the ditches are not defended. This defect results from the relief or height of the works, and from the nature of the weapons. Beneath the plane of fire which passes over the covering line and superior slope of the parapet, there is included an undefended space comprehending the whole or great part of the ditch. Consequently no sooner has the assailant descended into the ditch, than he is sheltered from the fire; and he may there form to attack the scarp, &c. In the preceding angular systems, all the re-entering angles are *dead;* that is, totally destitute of fire.

Fifth system. Bastioned lines.

It was natural to try to discover a system of lines exempt from the defects of those precedingly described, and that would possess the essential property of having the ditch flanked and defended throughout its whole extent. These conditions are fully attained by the system of *bastioned lines.*

Connected bastions to form a continued defensive front: tracé of the bastioned front. (fig. 14.)

In the same manner that we connected two redans by a curtain, we may connect two bastions to form a continued defensive front. Let us suppose; 1st, that the distance of the capitals of bastions be such, that the flank fires on the capitals are effective; 2d, that these fires directly enfilade and scour the face of the collateral bastion; 3d, that the interior of the bastion is spacious, and convenient for manœuvres. Agreeably to these essential conditions, which the tracé should realize, the faces of the bastions will tend to meet the summit of the re-entering angle formed by the curtain and the flank.

Nomenclature of the parts of the bastioned front.

The salient angle formed by the *faces* of the bastion, is the *flanked angle gco.*

The angle formed by the face and the flank, is called the *angle of the shoulder cgh.*

The line connecting the two bastions, is the *curtain fh.*

The angle formed by the curtain and the flank, is called the *flank angle ghf.*

The prolongation of the face to the flank angle, is the *line of defence cf.*

The angle made by the flank and line of defence, is called the *angle of defence efc.*

The line joining the two flanked angles, is called the *exterior front ac.*

Length of the exterior front

As the line of defence should not exceed 130 mètres (200 yards), it follows that the exterior front should be included between the limits of 200 to 250 mètres (225 to 280 yards).

Tracé of the bastioned front

The tracé of the bastioned front is very simple, and is drawn by the perpendicular *bd*, which is made equal to $\frac{1}{9}$ or $\frac{1}{6}$ of the front: the point *d* marks the direction of the two lines of defence. On these 60 to 70 mètres (67 to 78 yards) are taken for the length of the faces; from the shoulder angle thus found, the flanks are drawn square on the line of defence, and thus the *flanks* and *curtain* are determined.

Tracé of the ditches; their defence.

The ditches are, as in the other systems, traced parallel to the directrix. By observing the plunge of the parapets of the flanks *gh* and *ef*, which intersect each other below the line *bd* drawn through the centre of the bottom of the ditch of the curtain, or at this very line, we find that the flanks overlook and command the whole extent of the ditch, except the part masked by the reverse of the counterscarp *r s*. To remedy this defect, we must lessen and conduct this counterscarp in a

lengthened slope towards the opposite flank, or at least towards the part corresponding with the prolongation of the ditch of the face.

Examination of the bastioned system.

To examine this system, let us draw through the flanked and shoulder angles the extreme lines of fire, and we will find; 1st, that the fire from the flanks upon the capitals and approaches of the counterscarp, are very effective, but of little extent; that the fires of the faces cannot effectively cross on these capitals, and must only be considered as direct fires. Accordingly the capitals are badly defended in front of the counterscarp: 2d, that the ditches are well defended throughout their whole extent, and do not afford any cover under which the assailants may make dispositions to storm the scarp: 3d, that the system affords re-entering parts that are very strong, and difficult to assault: 4th, that the salient parts are sufficiently wide to allow for the artillery and infantry manœuvres. The only essential defect that we have discovered, proceeds from the shoulder angles producing sectors destitute of fires upon the capitals. This may be remedied by breaking the curtain into two parts, so that the half curtains *fk* and *hk* will fire on the capitals; but in this case the ditch of the curtains would not be flanked, and the flank angles would be *dead.*

Improvement by breaking the curtain into two parts.

80. Lines in which many kinds of elements or figures are used, are called *combined* or *complex lines;* they are combined in the most advantageous manner, and selected according to the ground.

80. Continuous *Complex Lines.*

The first complex system of which we will speak, is that of a right line hastily intrenched and subsequently covered by detached bastions. This species of tracé is advantageous when we can inundate the ditches of the rectilinear intrenchments with water. Care must be taken to cover the bridges with small palisaded redoubts.

First system of *Complex Lines;* the right line covered by detached bastions. (PLATE XI. fig 15.)

The second system of *complex lines* that we will take for an example, is composed of great bastions or *bonnets de prêtre B, B,* distant from each other about 800 mètres (nearly 900 yards), and connected by curtains broken into cremaillère. The centre of the front is occupied by a great tenaille *A*, towards which the branches of the cremaillère converge. In this system the bastions, or *bonnets de prêtre*, are the principal works, and should project far in advance of the cremaillères, so as to oblige the enemy to direct his attacks against these salient parts

Second System of complex lines; of bastions or *bonnets de prêtre,* and *cremaillères.* (PLATE XI fig. 13.)

which must flank and take in reverse the collateral parts, by which they in return are flanked; and these should be so armed and prepared, as to sustain the part that they are intended to maintain in the system.

Bastions of great dimensions seem preferable to the *bonnets de prêtre*, because the flanked angle is not *solely* dependent on its own strength after the enemy has reached the counterscarp and leaped into the ditch; this is the case with the re-entering part of the *bonnet de prêtre*, which is only protected by its own strength.

We will see in the conclusion, that we may use the elements of continuous lines as detached or isolated works, so as to occupy positions by systems with intervals, which are frequently preferable to a continued or connected system.

81. Manner of connecting one directrix with another in the tracé of lines, whether the angle be salient or re-entering.

81. When the base line on which a simple or complex system is traced changes its direction, it produces salient or re-entering angles in the defensive polygon requiring particular attention. Whenever the change of direction forms a re-entering angle, the general disposition is favourable to the defence; and if the angle be a right angle, it is defended by the mere tracé, and it is only requisite to profile it. If the angle be obtuse, it must be corrected by establishing upon it a redan with faces perpendicular to the branches. And if the angle be acute, it is hardly possible to suppose that the enemy will attempt to rush between two fires; but if a rectification be desirable, it is sufficiently effected by breaking the summit of the angle into a right line, to afford direct fires; or place upon it a redan, as in the case of an obtuse angle.

Of the re-entering angles

Salient angles, formed by changes of direction in the tracé of connected lines. (PLATE XI fig 16, 17 and 18.)

Changes of direction in the general tracé that produce salient angles, are weak points that the enemy will select for his attack; because he can reach them more easily, and their defence from the collateral parts diminishes in proportion to the acuteness of the angle. It is therefore necessary to make dispositions on these salient points, to obviate their weakness. As the salient angle, however small it may be, is from its nature weak, and the defects or disadvantages of it are felt in proportion as the angle is less obtuse, we must not increase these defects by any dispositions in front of it presenting a more acute angle.

When the angle is obtuse (fig. 16)

When the angle is a right angle. (fig. 17.)

When the angle A is obtuse, it may be retained and defended by the two lateral dispositions B, B', projecting very far out and flanking the ditches. If the angle be nearly a right angle, we

may take its summit for the flanked angle of a bastion, defended by two collateral half bastions B, B', advanced in front of the base lines AX, AX'. If it be found that the bastions B, B', do not sufficiently defend the capital of the bastion A, there may be constructed in front of the curtains the two redans or flêches F, F', the fires of which will be very effective.

When the angle is acute. (fig. 13)

The acute angle is the most disadvantageous, and it requires more labour to fortify it. The two bases AX, AX', form the acute angle A of about 60 to 80 degrees; this point must be considered as the summit of a detached *lunette*, having its faces on the directions AX, AX'; then take on these bases the quantities Aa, Ab, of about 120 mètres (135 yards), draw the right line ab and the two new capitals fc, dc, and on these take the quantities bo' and ao of about 40 mètres (45 yards); on oo', as the exterior side, construct a bastioned front, the faces of whose half bastions will flank the faces and capital of the lunette A. If it be not contemplated to incur so much labour, we may take up with the figure $orAr'o'$.

82. The outlets that must be made along the extent of continuous lines.

82. In all defensive dispositions it is indispensable to make through the intrenchments passages or outlets to communicate with the exterior, for the purpose of establishing guards and outposts (*les relations de surveillance*), and bring supplies into the camp. Most generally such communications have been considered for these purposes only; but they may be made use of for much more important objects, if disposed in relation with the movements that the assailed should make to the exterior, to act against the attacking columns already shaken by destructive fires. Such a sortie, made with great skill and fury, will almost always result in victory. Accordingly, by means of outlets sufficiently numerous and wide, the defending party may quit his intrenchments as we abandon a defensive for an offensive weapon, and assume the offensive outside. If they be repulsed, and know how to manœuvre, their retreat to behind the intrenchments is secured; and they may there continue the combat in a defensive attitude.

Rules for the dimensions and placing of outlets

It follows from these considerations, that the outlets made across intrenchments should be very numerous and sufficiently wide for the passage of columns and cannon; that they should be situated on the most re-entering parts; and lastly, that they should be masked from the sight of the enemy, and sheltered from his batteries.

This general rule shows, that the placing of outlets in intrenchments is various in each system, as well as the figure of the detached works wherewith they are covered.

Dimensions and manner of closing the outlets

The breadth of each outlet or passage, should be at least 4 mètres (4½ yards); frequently two passages are joined together to make one of 8 mètres (9 yards) wide. These openings are closed by short *palisades*, *barriers*, or *chevaux de frise*; these we will describe hereafter.

Placing the outlets in the different systems

In the system of redans, one outlet (either single or double) is generally made in the middle of the curtain, and covered by a redan called a *demi-lune* or half moon, between the extreme of the faces of which and the counterscarp, there is an interval of 12 to 15 mètres (13½ to 16¾ yards) for the troops to debouche through. If it be necessary to have two passages on each front, they may be placed at ⅔ of the curtain, covered each by a small redan capable of holding a guard of 15 men. In any case, the parapets of these small covering works must be lower than the parapets of the intrenchments; and care must be taken to mask all the openings by interior defensive traverses, from which to fire on the enemy attempting to force the barrier.

In the systems of swallow tails (*queue d'hironde*) and tenailles, these openings must be in the re-entering angles, or on the right or left of these angles.

In the system of cremaillères, the openings should only be placed on the extremity of the branches, and the covering redan is constructed on the prolongation of the next branch: in this tracé there is only one debouchè for each passage or outlet.

In the bastioned system the outlets are generally in the middle of the curtains, and are covered by a half moon. Two might be placed on each front; one on the right, and one on the left of the perpendicular; but it is better to make *only one*, the width of which may be double.

Bridges to cross the ditches.

Bridges to cross the ditches, are generally composed of masses of unexcavated earth. These bridges require no labour; but they weaken the intrenchments. It is therefore preferable, when we have time and timber, to excavate the whole ditch and construct the bridges of rough light timbers, covered over with large logs and rammed earth; the string pieces (*longerons*) must be supported from beneath, which should be filled with

small wood and very dry fagots. In the event of an assault, or a retreat that the enemy might be disposed to harass, and when there is no time to remove the wood and timbers, the bridges are fired and broken down*. Many intrenchments have been forced in consequence of neglecting these precautions.

83. *Lines with intervals*, are those whose direction is interrupted, and the tracé of which is by parts, with greater or lesser intermediate vacancies; or they are continuous lines, with outlets nearly equal to the fortified fronts and perfectly open. 83. Lines with intervals.

Many are in favour of lines with intervals; they certainly possess properties of which the continuous lines are destitute. By having great openings through which bodies of troops may debouche against the enemy, the General may hope to strike some decisive blow and assume the offensive at the moment that he thinks the enemy already staggered by the cross fires of the fortified heads. On this hypothesis, the troops stationed in the rear are like moving curtains in the defensive system, and constitute more or less considerable re-entering parts; the portions of the line are the salients, which the enemy must first carry before he can come in contact with the defending and supporting army. Strength of lines with intervals.

Let us suppose that we have to construct a line with intervals on a front of greater or less extent, and making part of an intrenched position; we may in such case divide the whole front to be fortified into equal parts of 200 mètres (222 yards), each of which will be alternately open and fortified. Each fortified head having a separate front of 200 mètres, should scour the ground on its front with artillery and musketry fires, and cross the fires of its flanks with those of the collateral heads on the ground in front of the intervals between them. This disposition places all the parts of the front in relations of de- Lines with intervals, and swallow tails or *bonnets de pretre*.

* It must certainly be preferable to use explosion to destroy the bridge, from the ruins and splinters of which, if it be inclined towards the exterior, no danger need be apprehended by the defending party. By timing the firing of the mine or little magazine, we may do the enemy much harm, and destroy many of his troops. Any other mode, such as burning the bridge, would produce a smoke to cover the enemy and annoy the defendants. Besides, lines are evacuated in general as secretly as possible: such a conflagration would be a signal for the enemy to pursue.

TRANSLATOR.

fence. Each part may be a swallow tail (*queue d'hironde*) or priest's cap (*bonnet de prêtre*), composed of a central redan and two cremaillère branches; care must be taken to cover the flanks by returns furnished with barbettes.

We see that in this system the assailants will be obliged to force all the separate fronts, before they can force the intervals; and that the defending party will be free to act against them when they fall into disorder, or to recive them in an unbroken order of battle behind the intrenchments.

CHAPTER III.

The Arming of Intrenchments; Batteries; Construction of Intrenchments; the Disposition of Batteries.

Remark.

WE will complete what relates to *lines*, before we treat on works of the second class. What we are about to lay down on batteries, the arming of batteries, construction, &c., readily applies to all those kinds of works whose theory is yet to be explained.

84. Arming of intrenchments generally.

84. The arming of intrenchments, comprehends all the necessary dispositions that must be made to bring all the arms into action to the greatest advantage.

Dispositions for infantry.

For musketry fires, it is only necessary that the banquette be properly raised, that the breast height of 135 centimètres (4½ feet) have a slope of 30 to 40 centimètres (12 to 16 inches), and that the superior slope of the parapet be well defined and perfectly plane.

Dispositions for artillery, generally called batteries.

For artillery, the dispositions are more complex, requiring particular labours, and a judgment in posting the pieces that is of the greatest importance; all these dispositions come under the general designation of *batteries*.

85. General description of batteries (See *L'Aide Memoire*, pages 938 & 630)

85. We have seen that in orders of battle several pieces of artillery acting together on the same position, are called a *battery*, and that *fixed batteries* are covered by a great epaulment. In field intrenchments, and in works for the attack and defence of places, the term *battery* is applied to all works in which cannon are to be used. Under this general point of view we will now consider *batteries*.

Barbette and *embrasure* batteries. (See PLATE XII)

All covered batteries are divided into two classes; the first comprehending *barbette batteries*, and the second *embrasure batteries;* both should be used in the armament of intrenchments; their combination depends upon the system used.

Barbette batteries, and their advantages.

Batteries that fire over the covering bank, the slope of which is beneath the chase of the piece, are called *barbette batteries:* they are advantageous, as their field of fire is unlimited, and they can follow the movements of the enemy. They are chiefly suitable for field works and for cases of warm, but short actions.

The barbette, its dimensions, and ascending slopes or ramps.

The barbette is merely a banquette sufficiently raised for the chase of the piece to pass over the parapet or epaulment; the soil or surface of the barbette is consequently 100 to 120 centimètres ($3\frac{1}{3}$ to 4 feet) below the covering line; its length is 4 mètres ($4\frac{1}{2}$ yards) for each piece, and its width 7 to 8 mètres ($7\frac{2}{3}$ to 9 yards). The ascent to barbettes is by *ramps* 4 mètres ($4\frac{1}{2}$ yards) wide, and whose inclination or slope is 6 to 8 times their height: this slope in our profiles must have a base of about 10 mètres (11 yards).

The *genouillère.*

The breast height of barbettes, is called the *genouillère;* it is very solidly constructed by the artillery soldiers with saucissons or sods, as we will hereafter describe.

Embrasure batteries, and their nomenclature.

In many operations it is necessary to cover the guns as much as possible, and for this end *embrasure batteries* are constructed, which we will now describe. Whenever it is intended to entirely cover the guns of a battery, there is erected in front a covering mass called *epaulment* or *coffer of the battery*, made of earth taken from the ditch in front, as in intrenchments.

The epaulment or coffer, and its dimensions.

Remark.

In defensive dispositions that are to be armed, the parapet serves as an epaulment.

Thickness of the epaulment, its height and length.

The epaulment of a battery has a thickness proportioned to its use, of 4 to 6 mètres ($13\frac{1}{3}$ to 20 feet). Its height is always 200 to 240 centimètres ($6\frac{3}{4}$ to 8 feet); and the length is at the rate of 5 to 6 mètres ($16\frac{2}{3}$ to 20 feet) for each piece.

The interior and exterior sides of the battery.

The interior side of the battery, against which the guns are placed, is the *face of the epaulment.* The *exterior side*, is that which looks towards the direction of the fire, and is parallel to the first.

Of embrasures, their bottoms, cheeks and figure (PLATE XII. fig. 1.)

The *embrasures* are the openings necessarily made in the epaulment, and through which to run out the chace of the piece in firing. Every embrasure has a *bottom* (*fond*) or *glacis*, and two lateral *cheeks* (*joues*). It is obvious that the interior side of the glacis of the embrasure, should be raised above the surface of the battery 100 to 120 centimètres ($3\frac{1}{3}$ to 4 feet), according to the caliber of the pieces.

The figure or horizontal projection of embrasures, has undergone many variations. They were originally made narrow in the centre, and wide at the interior and exterior; but as the blast of the shot soon destroyed the angles, the necessity was felt of bringing the narrow part to the interior side, and gradually the opening was brought into the form of a trapezoid,

the interior line of which is as small as possible, and the exterior sufficiently wide to afford a proper field for the fire: moreover, the glacis is slightly sloped from the interior, and affords a plunging fire.

Interior and exterior horizontal dimensions of embrasures.

If the thickness of the parapet be supposed to be 6 mètres ($6\frac{2}{3}$ yards), then the interior opening must be 60 centimètres (2 feet), and the exterior 300 (10 feet). If the thickness of the parapet be less, the exterior opening is in the same proportion. These dimensions have been established by experience. The *genouillère* is the height inside, from the surface of the platform to the bottom of the embrasure. The *merlons* are the masses of the epaulment between the embrasures; their extremes are the *half-merlons*.

The genouillère.

Merlons and demi-merlons.

Directrix of embrasures, direct and oblique.

The *directrix of an embrasure*, is the line of fire from the interior point corresponding to the axis of the piece, to the object to be battered. When this directrix is perpendicular to the side of the battery, the embrasure is said to be *direct* or *straight*; when it is inclined, the embrasure is said to be *oblique* or *slanting*.

Tracing the embrasures.

It is evident that the directrix is the line that should regulate the tracing of an embrasure. When the embrasure is direct, it is easily laid out, by marking off on the right and left of this line half of the dimensions that we have laid down for the interior and exterior openings. When the embrasure is oblique, it must be so made that the cheeks shall be in the same relation to the directrix as if the opening were direct; this requires but a very simple graphical operation. It is to be observed that in direct embrasures the cannon rests against the battery, and the chace extends as far as possible into the opening. This is not the case in the oblique embrasure; the cannon then rests against a beam called the *heurtoir*, about 265 centimètres long (nearly 9 feet) and perpendicular to the directrix which cuts its centre, and lying against the battery on the side of the acute angle. This line being drawn, the portion of the directrix included between it and the battery, gives the eloignment of the gun, which must be added to the directrix, fixed at 6 mètres ($6\frac{2}{3}$ yards), measuring from the exterior; to this extremity then draw a perpendicular, and mark off upon it on the right and left the half exterior width of 150 centimètres (5 feet).

Defect of the slanting embrasure.

Slanting embrasures weaken the epaulment in propor-

tion as they are oblique ; this is the reason that they should be used as seldom as possible.

Embrasures of howitzer batteries; their interior and exterior openings; their bottoms. (PLATE XII. fig. 1.)

Embrasures of howitzer batteries are traced like those for cannon, except that the interior opening is wider, being about 80 centimètres ($2\frac{3}{4}$ feet); the exterior is 300. The bottom of the embrasure declines in a counter slope of 12 degrees from the *exterior*, in cases where the fire should be under this angle ; in all other cases the embrasure is made much the same as for cannon.

Mortar and stone mortar batteries.

Mortar batteries do not require embrasures, because they fire under elevated angles, and it is merely necessary to eloigne the pieces a certain distance from the epaulment, by which they are always entirely covered. In the part on the attack and defence of places, we will complete the description of these batteries.

Remark.

Platforms of gun batteries.

In fixed field batteries and batteries on intrenchments, we content ourselves generally with well ramming and levelling the earth that forms the surface of the batteries and on which the carriages are worked. When this surface is floored, it is called a *platform.* In the batteries of which we speak, when greater solidity is required, a platform is made of planks sunk in the earth and secured by pickets. But when the batteries are destined for heavy calibers and for continual and long service, these floorings are inadequate. In this event, which is the case in the attack and defence of places, solid platforms must be constructed capable of resisting the re-action of the carriages.

Description of the cannon platform.

The platform is a kind of solid flooring, established to sustain the piece in the position proper for firing. The platform for cannon firing through embrasures, is established on the surface of the battery, after it has been well raised, rammed, and levelled for a length of 7 mètres (nearly 8 yards) and a width of 4 to 5 ($4\frac{1}{2}$ to $5\frac{1}{2}$ yards).

Timbers of a platform.

This flooring is formed of the following pieces of timber:

1st. A heurtoir ; this is the timber that is placed against the *revêtement** when the embrasures are direct, and against which the wheels of the piece in battery rest when the embrasures are oblique : the length of the heurtoir is 26 decimètres ($8\frac{2}{3}$ feet),

* *Revêtement,* is the facing sods, wall, or saucissons, &c. of a battery, scarp, or counterscarp.

and its thickness is 220 millimètres by 220 (nearly 9 inches by 9).

2d. Three or five sleepers, 46 decimètres (15½ feet) long, and 135 by 135 millimètres (5⅓ inches) thick.

3d. Fourteen planks 33 decimètres (11 feet) long, by 325 millimètres (13 inches) broad, and 55 thick (2⅕ inches). All these materials being ready, and the ground levelled 1.215 mètre (4 feet) below the bottom of the embrasure, the flooring is then laid.

Laying the platform.

There are two modes of placing the heurtoir; 1st, to place it with the fore ends of the sleepers resting against it; or 2d, to lay it upon the sleepers after they are laid down. We recommend the first method, for it might happen that a bomb falling on the flooring of the platform, may throw up the heurtoir; but if it be detached from the sleepers, such an accident would derange it less.

Placing the heurtoir.

We begin therefore by laying the heurtoir square upon the directrix, which should cut its centre; it must be placed perfectly level and only sunk 135 millimètres (5⅔ inches), and strongly secured by pickets. A small ditch is then made on the direction of the directrix, and in this the first sleeper is placed; its central line and the directrix must be the same line; its fore end must rest against the heurtoir, and must slope from the rear down to the front of the battery about 80 millimètres (3⅓ inches). The other 2 or 4 sleepers are then laid parallel and in the same manner, but so that the central lines of the two outward sleepers will be 1.62 mètre (5½ feet) apart; in order that the wheels of the carriage, whose riding bed is 1.54 mètre (5⅛ feet Eng.), may rest on the solid part. The sleepers (*gites*) having been well secured by pickets, and in the same inclined plane, they are then covered over with the 14 planks, the front one resting against the heurtoir. If the battery be for ricochet firing, the platform should be horizontal. If the battery be direct (*à plein fouet*), the inclination may be doubled, and increased to 160 millimètres (6⅔ inches).

Placing the sleepers.

Placing the planks.

Slope of platforms.

Platforms for howitzers.

Platforms for howitzers and stone mortars.

Platforms for howitzer batteries are made without any slope, and like those for cannon, except that they may be sunk in the ground as far as the genouillère; this shortens the work without impairing the effect of the fire.

Mortar platforms are composed of one flooring 2 mètres square (6⅔ feet), solidly and horizontally established. To

make this flooring there is required; 1st, 3 sleepers or bottom joists (*lambourdes*) 20 decimètres (6¾ feet) long, and 220 by 220 millimètres (8⅔ by 8⅔ inches) thick: 2d, 9 or 11 covering joists, according to the caliber of the mortar, and of the same length and thickness.

Tracé and construction of the epaulment.

We may without disadvantage, in order to diminish the labour and accelerate the work, sink these batteries 12 decimètres (4 feet). The ground being well levelled, and the epaulment prepared, we find the direction of the fire with two stakes stuck in the epaulment. On this line and at 23 decimètres (7¾ feet) from the epaulment, a perpendicular is drawn, marking the interior side of the platform. The 3 sleepers or joists are then buried in parallel ditches, the first with its central line in the directrix, and the centre lines of the two others distant 81 centimètres (2¾ feet) from the directrix. On these sleepers thus firmly established, and whose fore ends shall be 23 decimètres (7 feet 9 inches) distant from the epaulment, the 9 or 11 covering joists are then laid, fastened with strong pickets and raised 112 millimètres (4½ inches) above the ground of the battery: the ground round about the platform must be well rammed. The centre of the platform will be found to be 33 decimètres (11 feet) distant from the epaulment, which is far enough for firing bombs.

86. Construction of intrenchments and batteries.

86. The construction of the intrenchments that we have described, is effected by excavating the ditches, causing the earth to be removed in the most advantageous manner, and forming the covering banks and batteries according to the profiles. Common labourers and terrace-makers, under the superintendence of the conductors of the works, form the banks and slopes; but the construction of the breast height and of the merlons and embrasures of batteries, requires special materials and the aid of the soldiers of the artillery and engineers.

Materials, besides earth, used in constructing intrenchments.

The materials which nature has provided every where, and that are fit for these constructions, are *sods* (*gazons*), *fascines*, *saucissons* and *gabions*.

Fascines.

Fascines are bundles of small branches 20 decimètres long (6¾ feet), and 65 centimètres (2⅙ feet) in circumference, fastened together by two or three withes (*harts*). Cavalry and infantry go by detachments into the woods to make fascines, and are paid for them at the rate of 2 francs (37 cents) per hundred; the country people also make a great many of them.

(PLATE XII. fig. 4 and 5.)

Saucissons are cylindrical bundles of twigs and picked shoots, without sinuosities, laid one upon another with great care. These twigs are strongly tied together with withes at intervals of 22 centimètres ($8\frac{2}{3}$ inches). Saucissons are 6 to 7 mètres long ($6\frac{2}{3}$ to $7\frac{4}{5}$ yards), and are 32 centimètres (13 inches) in diameter: they are made by the artillery soldiers at the deposite for fascines, or on the ground where the batteries are.

Saucissons, and the manner of making them.

The *gabion* is a basket without a bottom; great quantities of these are used, especially in sieges. The diameter of the common gabion is 50 centimètres (20 inches), and it is 100 high (40 inches): seven pickets 114 centimètres (45 inches) long, are required to make it upon.

Gabions, and manner of making them.

They are very easily made. Having described upon the ground the circular plane of the gabion, the 7 pickets are vertically planted on its circumference, at equal distances, and strongly wattled together with straight green twigs of about 30 millimètres (a little more than 1 inch) in diameter, and connected close together from the bottom to the top. When the basket is finished, the upper and lower circumferences are tied with withes, and the points of the stakes are sharpened. The weight of the gabion is about 60 pounds.

When wood is scarce, and meadows are at hand, sods (*gazons*) are frequently used. They are cut with the spade from very grassy, but close mowed meadows, and are in the form of a trapezoid, the plane of which is a rectangle 40 centimètres by 16 (16 inches by $6\frac{1}{3}$). Its profile is a trapezium of 20 centimètres by 15 (8 inches by 6) in thickness, which is reduced afterwards to 12 ($4\frac{3}{4}$ inches).

Sods, their figure and qualities.

Four square mètres will give about 50 good sods, and an expert labourer will cut 1000 sods in a day. A turf cutter cuts in a day's work, 40 mètres (45 yards) of turf.

Having acquainted ourselves with the several kinds of materials used for constructing intrenchments, we will now give some idea of the mode of using them.

Manner of using the materials in constructing intrenchments.

The tracé of the work upon the ground having been completed, small ditches are made to mark the two breadths of the ditch, and of the berme; the remainder of the profile is drawn by perpendicular stakes, set up at all the angles and even in the centre of long faces or branches. These lines show where the excavated earth should be deposited; great pains must be taken to strongly picket and determine the height of the covering line.

Excavating the ditch and disposition of the workmen along the tracé. The number of workmen, and time necessary to construct intrenchments.

The labourers are posted along the length of the ditch in sets of 2 or 3, furnished with pick-axes and shovels. Each set is tasked with digging and excavating a vertical parallelopiped, having for its superior base a rectangle or trapezium 15 decimètres (5 feet) wide, and the length of which is the breadth of the ditch. The earth out of the ditch for the embankments, is thrown up at one or two throws, the first of which is lodged upon the berme. In front of each set of ditchers, there is a terrace-maker who levels and spreads the earth that is cast up, and forms the covering bank. Accordingly to ascertain the number of workmen required to construct an intrenchment, we must multiply the mean length of the ditch, estimated in decimètres, by the fraction $\frac{4}{15}$*.

Facts derived from experience respecting working in common earth their application.

We know from experience, that a labourer working in ground into which he can easily sink the spade, can dig and load up 1360 cubic decimètres (50½ cubic feet Eng.) per hour, or 43 cubic feet (French); and in 10 hours, which make a day's work, 13600 cubic decimètres (504 cubic feet) or 432 French cubic

* The usual calculation of what a man with a wheel-barrow can wheel in a day, is two cubic toises of earth, to a distance of one relay or 20 yards, when on ascending ground: but four men, disposed in relays of 20 yards, may wheel the same quantity 80 yards. It has been observed that 150 wheel-barrows contain two cubic toises of earth; and that a man in one day on a rising ground, may wheel them to 20 yards distance; this makes him walk, going and returning, 20,000 yards or about 4 leagues. If the ground be level, the same man may wheel the same quantity to the distance of 30 yards, which then forms the distance of the relay, and makes each fatigue man walk six leagues in the day's work.—(*See Memoirs of the French Engineer Corps on the Perpendicular Fortification.*)

Teilke (*in his Field Fortification*) says, it is considered an excellent summer day's work for a labourer to dig 216 cubic feet of earth. In digging there should be two shovel-men to one pick-axe-man. The various kinds of labourers should be in this proportion — a with shovels; $\frac{1}{3}$ a with pick-axes; $\frac{1}{6}$ a or $\frac{1}{8}$ a with baskets or wheel-barrows; and one man for every two feet of the directrix, to lay fascines and finish the parapet. These should be relieved two or three times in the 24 hours. In a sandy soil $\frac{3}{4}$ of the labourers have spades, and $\frac{1}{4}$ pick-axes. In a clay soil $\frac{2}{3}$ have spades and $\frac{1}{3}$ pick-axes. In rocky or gravelly soil $\frac{1}{2}$ are equipped with spades and $\frac{1}{2}$ with pick-axes. To calculate the cubic content of a ditch 12 feet wide at top, and 4 feet wide at bottom, and 6 feet deep and 4 feet long, we have the following formula:—

$$12 + 4 = 16 \div 2 = 8 \times 6 \times 4 = 192 \text{ feet.}$$

And in the same way for any other dimensions.

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feet. In applying this fact to the construction of intrenchments, we must observe that the ditch should be about 30 decimètres (10 feet) deep; and that if we divide this height into three layers of 10 decimètres each ($3\frac{1}{3}$ feet), the first may be very easily excavated, but the second will be more difficult, and the third still more so. Moreover, the earth must be thrown to a mean distance of 5 mètres ($5\frac{1}{2}$ yards), and even further; and this at the second and third layers, will require the labour of one of the men in each set. Therefore, along the length of the first layer, each set or working party will throw up for the embankments in 10 hours 16,000 cubic decimètres (590 cubic feet), in the second 12,000 (444 cubic feet), and in the third 8000; this gives a mean transfer of 12,000. If we suppose the breadth of the ditch at 80 decimètres (27 feet), the rectangle of each working party or set will contain 1200 square decimètres (133 square feet); and the proportion $\frac{12000}{1200} = \frac{120}{12} = 10$ will give the *mean depth* in decimètres that each set excavate in 10 hours work. Besides the two ditchers, each set must have a labourer upon the berme to throw the earth from thence to the embankment, and a terrace-maker to spread it and form the bank

Accordingly, in 3 days four workmen will be able to give to the intrenchment its first form on a length of 15 decimètres (5 feet).

A bastioned front 3000 decimètres (335 yards) in extent, will contain 200 sets of workmen; accordingly 800 men are required to fortify it in 3 days. And as 800 is the number of labourers that a battalion of 1067 men can furnish, and 200 mètres (223 yards) is the front that it occupies in battle, it follows that in 3 days a battalion can fortify its front. The time required may however extend to 4 or 5 days, according to the difficulty of breaking the ground.

A battalion of 1067 men can fortify its front in 3 days.

It is very important in practice, to regulate the ditching and strictly superintend it. We must not begin by breaking ground on the edge of the scarp or counterscarp, for the slope would be soon destroyed and could not be remedied. We must begin on the interior lines corresponding with the bottom of the ditch, and dig towards the scarp; conducting the excavation like an inverted glacis, rising from the scarp to the counterscarp. The first earth is thrown upon the site of the banquette. When we have arrived at the bottom of the ditch on the side of the scarp, the top of the parapet will remain to be formed; this will be done with the earth that is still lying upon the counterscarp.

Conduct of the excavation.

The relief being finished, the slope of the counterscarp must be rectified, and the excess of earth not wanting for the embankments, is thrown on the side of the counterscarp to form the small glacis. By these dispositions the intrenchments become defensible as fast as the work progresses; and by the evening of the first day it is possible to so dispose the embankments, as to avail ourselves of them in case of a sudden attack.

Instance that occurred at Cassel.

This was the case of the tête de pont of Cassel, when we had opened the ditches. A few days after we received orders to prepare the first embankments to receive the infantry and artillery destined to protect the retreat of the army, which was to be executed within two days. Similar preparations were made at different periods of the construction, and the works were constantly progressing under cover of formidable batteries, whose numbers successively increased.

The breast height, made of sods or fascines.

As soon as the bank or mound is as high as the banquette, the separate construction of the breast height is commenced with sods or strongly picketed fascines. Works made in fascines are quickly constructed, and resist the weather sufficiently long, provided they are well picketed and have a slope of 3 centimètres per decimètre (about 1 inch in 4). We have often used these kinds of works, and always with success; and we are of opinion that this construction is adequate for momentary batteries, and particularly for the genouillère of barbette batteries.

Sodding.

The breast height is also made with sods, when they are to be had on the spot. But this construction does not resist the severity of the seasons as well as the former; particularly when it is not made with great care.

Sodding is made by considering each sod as a parallelopiped, that, like bricks, is used for the revêtement; taking care to lay them with the grass downwards. The layers are alternately lengthways and athwart (*en boutisse et en paneresse*), and attention must be paid that each layer covers the interstices of that beneath; this is a precaution to be observed in all kinds of facings or revêtements. That the slope may be the more easily constructed, without weakening the sods, they are inclined a certain degree towards the horizon, instead of lying in horizontal layers.

Construction of the coffers, merlons and embrasures of batteries.

In constructing a barbette battery in a solid and durable intrenchment, the genouillère is often made with more care than the breast height. In this case, the artillery soldiers make to

the rough-formed parapet and barbette all the necessary modifications required by their arm; they level or raise the ground of the barbette, and lay the platforms, as we have described. Meanwhile they face the genouillère with saucissons, with four of which they give it the proper height; the first serving as a base, is more or less buried below the level of the platform.

When a battery is required to be constructed isolatedly and without previous labour, as in sieges, the artillery are alone charged with raising the work. The tracé is drawn in conjunction with the engineers; and these two corps determine in concert, the number and caliber of the pieces proper for the battery, as well as the mode of firing.

The coffer or epaulment of the battery being marked out, the earth is taken from a ditch in front, as for an intrenchment. This part of the work is performed by workmen from the line, whilst the cannoniers prepare the ground of the battery to receive the platforms, throwing the excess of earth on the site for the epaulment, and likewise prepare the number of saucissons necessary for the *chemise* or revêtement of the inside of the battery and the cheeks of the embrasures.

Disposition of the common labourers, in making the embankment of the epaulment.

For each piece of artillery we must allow 60 decimètres (20 feet) of epaulment, the earth for which must be taken from the corresponding part of the ditch by 12 labourers from the line; six of these dig the ditch, three are upon the berme, and the other three upon the coffer to spread and ram the earth. The eleven cannoniers required for this work, are busy in the interior of the battery as we have described, and in preparing 27 saucissons of 60 decimètres in length (20 feet). The coffers for mortar batteries are made in the same manner; but as they have no embrasures, 8 cannoniers and 21 saucissons are sufficient.

Making the revêtements and embrasures.

As soon as the ground of the battery is ready, and the workmen from the line have heaped up a quantity of earth 6 decimètres in height (2 feet) on the site of the coffer, the artillerymen begin the revêtement of the battery by making a trench 16 centimètres (6⅓ inches) deep and perfectly horizontal along the line of the tracé or ground plan, and in which the first saucisson is properly placed. The others are placed successively upon it, and four of them make the height of the genouillère. The knots of the withes are placed inside, and each saucisson is secured by 10 pickets. After the 4 saucissons that form

the height of the genouillère, are established and well rammed, picketed, and cut smooth and even, the interior openings of the embrasures are marked out (on which there should not be any joints), and the merlons are then completed by laying down the other four saucissons. The facing of the battery being completed, the revêtement of the embrasures is effected in the same manner, and the earth is supported on the outside by a row of gabions along the berme inclining inwards.

Laying the platforms.

It is after all this work is completed, that the artillerymen attend to the establishing of the platforms, in the manner we have described.

Time required to establish a battery under fire of the enemy.

The batteries that we now speak of, are those constructed under the fire of the enemy, and at a distance of 500 mètres (556 yards); this is the reason that the labour is chiefly performed in the night. Generally, by the third night we may hope to establish the platforms and place the pieces in battery, so as to open upon the enemy at break of day.

Reflections on ricochet batteries.

We would observe that in ricochet batteries the pieces being fired under angles of 6 to 8 degrees, embrasures may be dispensed with. The guns may be eloigned from the epaulment, the coffer sloped down from the exterior to the interior, according to the elevation of the fire, and the platforms laid 17 decimètres ($5\frac{3}{4}$ feet) below the covering line on the exterior. All these subjects belong to the attack and defence of places, and when we come to treat on that branch we will more fully illustrate them.

87. Conclusion on the armament of intrenchments, as related to artillery. (See St. Paul, page 155.) (See art. 65.)

87. The armament of intrenchments in artillery, consists in the manner of using this arm for their defence. This is a very important matter, and requires great judgment in the artillery and engineer officers. It is evident that the pieces should be distributed and established according to certain principles dependant upon the mode of attack. But this attack depends upon localities, and the nature of the defences; consequently the posting of the artillery should be determined according to the anticipated attacks of the enemy. We will now complete what we merely before sketched (art. 65) on the attack of intrenched positions, and thence deduce rules for properly disposing artillery on lines exposed to storm and escalade.

Mode of attacking intrenchments.

In attacks by storm upon intrenchments, we must distinguish several periods.

In the first, after a preparatory reconnaissance made by the General and the officers of artillery and engineers, the enemy posts his artillery at a distance of 500 mètres (560 yards), for the purpose of enfilading the faces of the works and battering direct all the points occupied by artillery. If in the defensive system there be long cremaillère branches, their prolongations are taken in order to enfilade them : a heavy firing of howitzers must be opened against the embankments of the parapet, abattis, palisades, fraises, &c. The troops, stationed to move in the directions proper for the attack, hold themselves during this first period out of reach. and concealed by the undulations, &c. of the ground. This period is solely the combat of artillery.

When the effect of the artillery has been such as expected, the second period of the attack commences. A displayed line of light infantry now moves forward to within 300 mètres (335 yards) of the intrenchments, driving in all that oppose them, and covering by their fire the second disposition of the artillery, which must now be posted 300 mètres from the works in the most advantageous manner to silence the enemy's artillery and ruin the defences. Skirmishers or sharp-shooters are advanced towards the very edge of the counterscarp, to fire upon the artillerymen posted upon the barbettes. Experience has demonstrated that these riflemen are the terror of artillerymen when not entirely under cover.

The moment that the artillery renews the fire, the whole move forward to the attack. Under cover of this fire, the columns of attack, composed of infantry of the line, advance ; followed by bodies of cavalry at some distance. The columns will have at their head parties of workmen commanded by officers of engineers, who direct them upon the capitals and on the several points by which it is intended to penetrate the intrenchments.

The third and definitive period of the attack, now ensues. All the dispositions having been completed under cover of the fire from the artillery and light infantry, the troops are put in motion ; the artillery remaining in the rear. The light infantry and some bodies of infantry of the line, in displayed order, move forward, firing on the intrenchments, and assault the counterscarp. During this firing the workmen clear the passages and remove all obstacles, so that the columns of infantry

of the line may descend into the ditch, ascend the berme, and get over the scarp. While these events are passing, the light and other troops must endeavour to form on the top of the parapet. As soon as the infantry have penetrated into the intrenchments, the workmen make passages for the artillery and cavalry; and all the troops form in order of battle inside of the works, to act according to circumstances.

Establishing batteries in intrenchments.

By these general modes or stages of attack, we perceive that there should be certain combinations in the disposition of batteries, and these of two kinds. The one, for the first and second periods of the attack; and the other, for the third period, during which the counterscarp and ditches are to be defended.

Necessity of establishing the barbette batteries *on the salients.*

The *first kind* of batteries should overlook far into the country, and have an extensive field of fire, in order to follow the various movements of the enemy's batteries and columns. Accordingly these batteries must be in barbette and on the salient parts of the works, to cross their fires on the collateral capitals and fire direct upon the capitals of the salients that are destitute of direct fire: a few batteries in barbette may also be posted on the curtains.

Embrasure batteries required to defend the counterscarp & ditches.

It is obvious from the stages of the attack, that the barbette batteries will be dismounted as soon as the third period of the attack commences. There must therefore be for this period batteries less exposed, well covered, and taking in flank and reverse the approaches to the counterscarp, and enfilading as much as possible the ditches and scarp. Embrasure batteries, judiciously placed on the re-entering parts and covered on the side of their exposed flanks by traverses of gabions, fulfil this object; and if served with coolness and firing canister shot, will render the attack very perilous.

Application of these principles to the bastioned system.

A bastioned system armed according to these principles, would present a barbette with 3 to 5 pieces of heavy caliber on the flanked angles, and a barbette at the extremities of the curtain 20 mètres (22 yards) from the flank angle, or a single barbette in the centre of the curtain; together with embrasure batteries at the angles of the shoulder, and on the flanks. These latter, if the enemy can enfilade the curtains, must be covered on the side of the flank and in rear by gabionnades*.

* A *gabionnade* is a traverse or epaulment made of gabions. See Plate XII. fg. 4. TRANSLATOR.

In complex works presenting many salient parts, it is on these salients that the barbettes are established; their flanks are defended by embrasure batteries on the re-entering parts. The tête de Pont at Cassel, was armed in 1793 agreeably to these principles; notwithstanding, the batteries of the flanked angles were made with embrasures, in spite of our opinion, which could not prevail at a time when sufficient experience had not been acquired respecting the proper use of artillery in intrenchments.

Example of the Tête de Pont at Cassel.

CHAPTER IV.

War Pits or Trous de Loup; Palisades and Fraises; Abattis and Chevaux de Frise; Closing of Gates and Outlets; the Cheval de Frise; the Military Barrier.

Secondary means used by engineers, to increase the strength of intrenchments.

ALL field intrenchments are generally weak against attacks, in consequence of the nature of the materials and the little time allowed for their construction*. The scarps and counterscarps have but a slight relief, and terminate in planes or surfaces inclined towards the horizon; these the assailants may easily get over, and fight man to man with the assailed. Accordingly field works are exposed to be attacked by assault; the resistance that they oppose is greater or less, according to their good or

* The weakness of intrenchments is more in consequence of the immobility of the defending troops, and the courage that human nature acquires in offence, than in the imperfection of the works. The attacking party may choose the time and *point* of attack; and by carrying their masses against this point, whilst they keep the remainder of the line in check by demonstrations and false attacks, they must generally succeed; for if the assailants have three or four times the force of the assailed at the *decisive point*, they must carry that point in spite of the valour and devotion of the defence. Should even one half of the assailants be cut down, they are still twice superior to the assailed, and at a moment when they have just surmounted the summits of the scarps and have struck their opponents with dismay and consternation. When the line is forced at one point, the whole is taken in flank and reverse, and the troops collateral to this point must retrograde or perish. And such is the temper of man, that passive resistance weakens his courage and destroys his confidence; from the very idea of remaining on the defensive, he becomes conscious of his own weakness and of the enemy's strength. Therefore lines with intervals should be preferred; their defence is active, and should terminate in bold offence. Besides, the loss of one point does not entail that of all points; and the troops may take moving orders of battle with the redoubts as points of support. These remarks apply to *armies* of *regular* troops, not to a few hundred or a few thousand men, nor to militia forces. Very few of the maxims of grand tactics have relation to small corps; masses are alluded to, which require considerable time and space to manœuvre and display. The science of manœuvres might therefore in its application to two armies, be called *manœuvring against time*; for the army that manœuvres with the greatest celerity, must, all things else equal, vanquish its adversary.

TRANSLATOR.

bad disposition. It is to correct these defects and increase the strength of the works, by rendering the assault slower and more perilous, that engineers avail themselves of the *secondary means* afforded by the country and their resources and genius. These *means* are: 1st, *trous de loup*, or war pits; 2d, *palisadings* and *fraisings*; 3d, *chevaux de frise*; 4th, *abattis*.

68. Pits, or trous de loup, made in the quincunx order (PLATE XII, fig. 1, & PLATE XI.)

33. *Trous de loup* are pits dug in the form of a reversed truncated cone, with a superior diameter of 20 decimètres ($6\frac{3}{4}$ feet), and an inferior of only 3 decimètres (1 foot), and 17 decimètres ($5\frac{3}{4}$ feet) deep. The excavated earth is thrown upon the edges of the excavation, with sufficient slope to prevent its falling and filling up the pit. At the bottom of each pit is planted a very sharp pointed picket 10 decimètres ($3\frac{1}{3}$ feet) high. To use these pits for defence, they should be made in 3 or 4 parallel rows, in the quincunx order. For this purpose equilateral triangles are drawn with sides of 7 mètres ($23\frac{1}{3}$ feet) long, whose extremes and middles are the centres of pits. The earth cast up between the intervals of the pits, makes the ground so broken that troops cannot form upon it. Their construction is very expeditious, requiring only hands and a few hours' work.

Circumstances in which these pits may be used with advantage.

These pits are used in many cases: 1st, in front of lines, to render their access more difficult, and to longer impede the march of attacking columns: 2d, against cavalry, when it is desirable to shelter one part of the line of battle from their attack: 3d, in accessible plains, that are to be defended by making use of small inundations. In this latter case the excavated earth is not to be formed into mounds, but must be so spread about, that no part of the ground will appear above the thin sheet of water which is about 30 centimètres (12 inches) deep.

Position of these pits in front of intrenchments.

Trous de loup in front of intrenchments, are generally made by tracing them 20 to 30 mètres (22 to 33 yards) from the salient parts, and nearly parallel to the faces or branches. They must be under the full effect of musketry; if the relief of the works be inconsiderable, it will be proper not to form mounds, but to scatter the excavated earth*.

* Trous de loup, when not covered by inundations, may be concealed by weak hurdles and branches or twigs, covered over with a thin layer of earth: this mode is recommended by Teilke, a man who had great experience in these matters; he served in the seven years war of the great Frederick.

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Trous de loup may also be made in the bottom of the ditches, and even immediately upon the edge of the counterscarp, by eloigning the glacis to a proper distance. In this last case, two rows of trous are sufficient.

Example and use of them

The defensive dispositions made at the opening of the last war (1792) along the Loutre, above and below Lauterbourg, were protected by trous de loup, without mounds, and covered by a sheet of water. The left bank of the Loutre was lined with them, and they were defended by bodies of infantry encamped upon the hills on the right bank.

On fronts of battle where attacks of cavalry are dreaded, and which cannot be repulsed by cavalry, trous de loup may be used with effect. Light infantry thrown out in rear of the pits, will frustrate all the attempts of the enemy, if the works be made without his knowledge and during the night before the battle.

89 Wood as a means of defence.

89. Next to earth, wood is the most abundant material that nature offers to engineers. Of this they should make frequent use, either for palisades, fraises, and abattis, to intrench interior redoubts, the gorges of works, &c; or to make caponnieres blinds, powder magazines, and traverses in the interior of the works.

The stake or palisade (PLATE XII fig. 3.)

The military stake called *palisade*, is in figure a trapezoid. The breadth of its base is 20 centimètres (8 inches), its large and small sides are respectively 20 and 10 centimètres, and its length is 30 to 35 decimètres (10 to 11$\frac{3}{4}$ feet). Each palisade is sharpened at the upper end, and care must be taken to harden by fire the lower end which is driven into the earth.

Palisadings.

They are used in all works to form palisadings and fraises. The disposition called palisading, considered separately, is a species of intrenchment.

A *palisading* is erected on a given direction by making a trench or ditch upon it, about 10 decimètres (3$\frac{1}{3}$ feet) in depth by 5 in breadth, in which the palisades are planted vertically or with a small inclination, and with their centres separated 28 centimètres (11 inches) apart, so that they form a sort of loopholes (*creneaux*).

The binding lath, placed breast high.

When the palisades are firmly fixed in the earth, they are joined together by a lath that is horizontal or parallel to the ground, and not exceeding 135 to 140 centimètres (4$\frac{1}{2}$ to 4$\frac{3}{4}$ feet) above it. This lath is 6 by 8 centimètres (2$\frac{1}{2}$ by 3$\frac{1}{4}$ inches) square, and is nailed or pegged upon every palisade:

sometimes they are fastened by two rows of laths, that the whole may be the stronger*.

The fraise. (PLATE XII. fig. 1)

The fraise is an horizontal or very inclined palisading, placed on the sides of works or on their exterior slopes. In establishing a fraise there must be fixed in the side of the work a beam called a *coussinet*, 30 by 30 centimètres (12 inches) thick, and so placed that its exterior face shall be horizontal or inclined, according as the fraise is to be inclined. On this beam the stakes are perpendicularly fixed and nailed, and should project out 20 to 25 decimètres ($6\frac{3}{4}$ to $8\frac{1}{2}$ feet); the coussinet is then covered over with earth.

Planting palisades and fraises in intrenchments.

The manner of placing palisades and fraises in works, is not without importance. In the campaign of 1792, in the army of the north, all the palisadings that we found established in the numerous intrenchments under the direction of foreign engineers newly appointed, were vicious; they were almost universally planted vertically upon the bermes. We obtained an order from the General to have them planted in fraises on the scarp, or as palisades on the counterscarp, covering them by a glacis.

There are but three ways of establishing fraises; on the edge of the counterscarp, on the berme, or on the slopes of the scarp and counterscarp. The first mode exposes them to be cut by the enemy. If placed on the scarp, they are liable to be broken by the rolling of howitzes upon them in quantities. Therefore the best disposition of them is 15 decimètres (5 feet) below the edge of the counterscarp.

Rule: Palisadings should be within arm's reach of the defending perty.

There are likewise many methods of planting palisades; but we would observe, that the disposition of these can only be strong in proportion as they are within arm's reach of the defending party. This is a principle that we think ought never to be departed from.

1st. Palisades upon the berm.

1st. If the palisades be planted upon the berme, they will be seen, and speedily ruined by the enemy's cannon and howitzers: this method must therefore be exploded.

* *Teilke* recommends planting the palisadings under a very considerable inclination towards the exterior; and likewise planting them alternately vertical and exteriorly inclined. This arrangement renders it extremely difficult to cut them down by hand. Such defences should be always attacked with cannon and howitzers.

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Palisades in the ditches.

2d. If the ditches be flanked, the palisades may be fixed in the middle, or at the foot of the scarp or counterscarp: it is less expedient to place them at the foot of the scarp, on account of the injury they may sustain from falling howitzes and bombs.

But if the ditches be not defended, these dispositions are vicious, and must not be used.

Palisades in advance of the counterscarp.

Vauban placed his palisades 30 to 40 mètres (33 to 45 yards) in advance of the counterscarp. A palisading thus distant, is badly covered by a false glacis, and is not under the arm of the defendants, who cannot protect it by the sword and bayonet: besides it serves as a cover to the enemy, who may cut it down with ease. We are of opinion that this method ought not to be used.

Palisades on the edge of the counterscarp.

A palisading 2 or 3 mètres (7 to 10 feet) from the counterscarp, and covered by a small glacis, should be preferred: if it be necessary, the counterscarp may be lowered 4 or 5 decimètres (16 to 20 inches). By this arrangement the palisades are defended by the direct fire of the intrenchments; and may also be protected by the bayonet, by placing behind them platoons of grenadiers. It must be observed that an armed man cannot leap from the crest of the glacis over the palisades, and that the workmen of the engineers will find it difficult to cut them down.

Abattis.

Abattis are excellent means of strengthening intrenchments: they are frequently used isolatedly, to mask openings and render parts of woods impenetrable. In this way we employed them at the beginning of the last war (1792), by crossing with a line of abattis part of the forest of Bewal, between Weissembourg and Lauterbourg; and these, defended by a few bodies of troops, rendered the forest impervious to the enemy.

Description of abattis. (See PLATE XII, fig. 1.)

Abattis are made with middling sized trees, or with heavy limbs full of branches, having all the slender boughs cut off, and the branches sharpened. The trees or limbs thus prepared, are laid side by side with their boughs and branches interwoven, and their sharpened points towards the enemy. To render the whole more solid and prevent the enemy from removing them, the trunks of the trees and limbs are pinned to the earth by crotchet pickets driven very deep. To attack such abattis, is a difficult operation, requiring cannon to ruin and cut openings through them.

The abattis with which Cassel was surrounded at the beginning of the works, were arranged in this manner, and placed 30 mètres (34 yards) from the salients and parallel to the faces of the works.

Placing of abattis in intrenchments (PLATE XII, fig. 1.)

There are several ways of placing abattis in intrenchments: 1st, establishing them at the bottom of the ditches; this can only be done when the ditches are well defended.

2d. Planting them upright against the counterscarp; but in this position they are easily thrown down by the enemy.

3d. Placing them in advance of the counterscarp, and covering them by a low and short glacis (*glacis coupé*). This disposition is good, and is that most generally adopted.

4th. Finally; placing them upon the terra-plain of the small covert way; this appears preferable to palisadings, and to the other methods of disposing the abattis.

Abattis at the moment of general battles.

It frequently occurs in the course of a campaign, that at the moment the two armies are ready to fall upon each other, abattis are made to cover portions of the field of battle. General Merci made great use of them in his position at Freybourg in 1644; and it required all the skill, prudence, and fortitude of Turenne, united to the desperate valour of the great Condé, to force the position thus prepared and defended.

At Fontenoy, Malplaquet, &c. there were great quantities of abattis, which were only established on the eve of those memorable battles.

The cheval de frise. (PLATE XII. fig 2.)

Before the use of artillery, great quantities of *chevaux de frise* were carried in the train of armies, and they were then, as in our days, used for several purposes; especially to cover parts of fronts of battle, and shelter them from the assaults of a numerous cavalry. The infantry likewise used them as a moveable intrenchment that was always ready at hand. Now-a-days, the chevaux de frise that are carried along with the artillery train, are of little other use than to close up the outlets and gorges of enclosed works, destroy fords, &c.

Description of the common chevaux de frise.

The *cheval de frise* is composed of an hexagonal beam 20 to 30 decimètres ($6\frac{3}{4}$ to 10 feet) long, and 20 by 20 centimètres (8 inches). On the six sides or faces 33 stakes called *lances*, are fixed, and are 15 decimètres (5 feet) long, and in thickness not exceeding 5 by 5 centimètres (2 inches); they are shod with iron. Each beam has its extremities furnished with an iron ring, from which a chain is extended with two eyes and fur-

nished with a *T*. This chain serves to unite together all the chevaux de frise, and form one whole of parts difficult to separate.

Chevaux de frise are made of white wood, with a view to render them light. The total weight of one, including the lances, is 53 kilogrammes (about 120 lbs. Eng.).

90. Closing the openings or outlets of intrenchments. (PLATE XII.)

90. We have already seen that openings or passages should be left in the least exposed parts of intrenchments, either for the movements of troops, or for communicating with the country without. These passages are closed in various modes, but most frequently with particular *chevaux de frise*, or by barriers. These obstructions are used at all posts, and are prepared by the troops to prevent surprise.

Description of the cheval de frise used for closing passages and outlets. (See *Guide de L'Officier en Campagne*)

This kind of *cheval de frise*, although a little complex, may be made by the common workmen found in every village. The description therefore of this work, forms part of those elements of fortification in which it is proper to instruct the young officer of the line, so that he may be able to conduct the essential defences of a post.

The body of the cheval de frise intended for closing an outlet, is 30 to 35 decimètres (10 to 12 feet) long, and 25 by 25 centimètres (10 inches) thick: when fixed, the diagonal of the section perpendicular to the axis, is vertical. It is sufficient to bristle it with lances set square on the 4 faces, or we may cut the beam into 6 faces or sides. The lances are set in grooves with iron bolts or heavy nails, and clasped with iron, the better to fix them to the body of the cheval. To make this machine moveable, one of the ends is cut and a hole of 10 centimètres (4 inches) is bored in it, to pass through the rounded head of one of the fixed upright posts. To support the other end of the cheval and give it an interior rotary motion, it is left of the rectangular form for a length of 30 centimètres (1 foot), and on the two upper faces four spindles (*fuseaux*) are set two by two in the same vertical plane and perpendicular to the axis of the body. These are fixed and strongly bolted, and joined together underneath by a cross piece. The two horizontal cross pieces are 15 centimètres (6 inches) apart; they are crossed in the middle by a bolt with a trundle. This trundle or wheel bears the whole weight of the cheval de frise, and traverses upon a circular timber fixed in the ground. This same end of the

cheval lies against the second upright post, and is fixed to it by a bolt or other means.

The barrier.

Barriers are more generally used in fortresses and large posts, than in intrenchments. However, by making them as simple as possible, they may be completed with sufficient dispatch to be put up as soon as the intrenchments are defensible.

Description of the great barrier. (PLATE XII, fig. 3)

In barriers, like that drawn in Plate XII, two things are to be distinguished; the two shutters (*battans*) that shut one upon another like the folds (*venteaux*) of a folding door, and the dormant frame (*chassis dormant*) on which the shutters move.

The dormant frame being established, should be immoveable, and capable of sustaining the weight of the two shutters. It is composed of many pieces more or less numerous, according to the intended strength of the barrier and its use. In the barriers of posts and intrenchments, the dormant frames are made as simple as possible.

The frame of a grand barrier is composed of;

1st. Two upright posts, 30 decimètres long (10 feet), and 24 by 27 centimètres (10 by 11 inches) thick:

2d. An under-threshold (*sous seuil*), to which the two upright posts are joined in mortice and tenon; its length is 52 decimètres (17½ feet), and 28 by 28 centimètres (11 inches) thick. The under threshold extends beyond the uprights on both sides about 12 decimètres (4 feet):

3d. Two horizontal coussinets, on which the under-threshold lies, which is notched 5 centimètres (2 inches) to receive them:

4th. Four coussinet braces, 2 under-threshold braces, and 2 running wheel braces (*liens chasse roues*):

5th. A threshold 32 centimètres (13 inches) higher than the under-threshold, and 30 decimètres (10 feet) long, exclusive of the tenons, and 20 by 23 centimètres thick:

This frame is well joined together and pegged and bolted, and is placed in the ground which should cover the threshold about 25 centimètres (10 inches).

Each shutter of a barrier consists of a frame, in which are distinguished; 1st, 2 upright posts 20 decimètres (6¾ feet) long, and 16 by 16 centimètres (6⅓ inches) thick; 2d, 2 horizontal cross pieces, one above, and the other below; 3d, 1 sling piece (*echarpe*); 4th, 7 spindles or laths.

In the upright posts of the opening (or shutters) a pair of

grooves are made 5 centimètres (2 inches) deep, and 10 centimètres wide, for the folding (*battée*) or closing of the barrier.

In each of the upright posts of the frame, from the threshold up, a groove 16 centimètres by 11 ($6\frac{2}{5}$ by $4\frac{2}{5}$ inches) is made to receive each upright of the barrier, which must be rounded to facilitate their circular play.

Iron work of the barrier.

The iron work of the barrier consists of;

1st. Two collars firmly fixed in the posts of the frame, and encircling the top of the uprights of the folds or shutters:

2d. Two pivots with arms and sockets, and on which the folds turn:

3d. Double bands, embracing and consolidating the union of the uprights and cross-pieces:

4th. A catch bolt to lock the barrier.

Frequently there is used, instead of a bolt, an iron latch (*fléau de fer*) turning upon one of the uprights of the fold (*battée*) and falling into two iron crotchets, and kept there by means of a catch (*tige*) let into a lock.

The sockets (*crapaudines*) are placed upon the threshold, when there is no pavement; and on a free stone, when there is a pavement above the threshold.

The plate sufficiently shows the remainder of these minute details.

General reflections.

The field of battle fortified by extended intrenchments, is now armed and provided with every thing that can contribute to its defence. It is palisaded or fraised, or covered with abattis, according to circumstances; and armed with batteries judiciously posted, that command far over the country and flank all parts of the defences.

If the General commanding understand fully the properties and power of the arms of artillery and engineering, and their relations with other arms; if he know how to manœuvre and direct his forces, so as to produce the effect that should be attained; it cannot be doubted but that he will be able to defend himself against a very superior army; and he may even obtain advantages that will enable him to rise from the defensive into the offensive.

CHAPTER V.

Enclosed Works, used separately, or in extended systems; Redans; Lunettes; Redoubts; Small Field Forts, &c.

91. Enclosed works, used separately or in extensive systems. (PLATE XIII.)

91. THE systems of extended lines that we have described, are not the class of works most frequently used in war. It is daily necessary to occupy particular points, isolated and unsupported by other works, and which must be defended by small bodies of troops or mere detachments, with little artillery. Sometimes they are destitute of artillery, and musketry is the only arm that must be depended on for their defence.

We will describe the works that compose this class; they are used according to circumstances and localities.

Conditions that enclosed and isolated works should fulfil, and which determine their general configuration.

A detached and isolated work being exposed to be completely surrounded by the enemy, should be sufficiently strong in itself, and its defences should make front on all sides. Its fire being in the direction of the radii of the curve, it follows from this requisite data, that the defensive perimeter should be in itself a re-entering enclosed figure.

Nomenclature of these works.

Such works are called *redans*, *flêches*, *lunettes*, *redoubts*, *small forts* (*fortins*), and *field forts* (*forts de campagne*), &c.

Profile and ground plan of the covering line.

In all these works, the profiles are the same as those we have precedingly determined; we have therefore nothing to add on the vertical projection. But we will carefully examine the properties and defects resulting from the extent and figure of the tracé or ground plan of the covering line; and then exhibit the use that is made of these works in war.

The redan; its properties and defects.

The first and most simple detached work is the *redan;* its figure we already know. It is used whenever its gorge can be secured by natural obstacles, or when troops are stationed in its rear to prevent the enemy from turning it. The tracé of this work is very simple; but its defects are numerous. The interior of the terra plain is very confined, and its capital is destitute of direct fires; its salient angle should not be less than 60 degrees, and whenever possible it is made a right angle. To obtain direct fires on the capital, the inside of the salient must be rounded; this is better than making it with a straight face (*pan coupé*). When there is artillery to defend

the redan, it is posted in the rounding of the salient angle, which is in this case made with a straight face (*à pan coupé*).

The flêche.

When the redan is advanced in front of other works that support and flank it, and when its dimensions are small, it takes the name of *flêche*. The sides of the flêche are 15 to 20 mètres (16¾ to 22 yards), and its angle varies from 60° to 30°.

The lunette.

When the faces of the redan are broken towards the interior, to form flanks and obtain greater space inside, without however excessively lengthening the faces, it assumes the figure of a small detached bastion, and is called a *lunette* or *piece* (work).

The dimensions of lunettes are 40 to 50 mètres (45 to 56 yards) for the faces, and 12 to 15 (13½ to 16¾ yards) for the flanks; the flanked angle is 70 to 90 degrees.

Lunettes and flêches having their gorges open like the redan, they are used in similar circumstances and when the enemy cannot turn and carry them by the gorge.

The redoubt; its most advantageous form.

All enclosed works that are intrenched on their whole perimeter and of moderate size, and whose figures are such as to furnish direct fires only, (without flanking fires,) are called *redoubts*.

Circular redoubts; their advantage.

Redoubts may be of any form; the figure which is least and most favourable to defence, all other things being equal, is that which is circular, or a polygon with sides of 1 mètre: this length corresponds to the line of musketry fire.

In the circular or polygonal redoubt, the fires diverge towards the country, and there are no parallel columns of fire; but then the fires are all equally distributed, and there are not on the circumference any considerable sectors destitute of fire, and against which the enemy may direct columns of attack. This figure possesses also the essential property of enclosing the greatest space by an equal perimeter.

But though the circular form be the most advantageous, and its tracé is very simple, and it would be proper to approximate to this form all the other figures; nevertheless nothing is more rare in war, than to find this form used. Square and quadrilateral redoubts only, are in general use.

Defects of the square or quadrilateral redoubt.

The square or quadrilateral redoubt has the defect common to all salients; that of having on the 4 capitals, 4 sectors destitute of direct fires, and consequently without any defence, as they are not flanked. Hence, the enemy may move upon the

capitals without sustaining any sensible loss, and gain the ditch without being touched.

Rounding of the angles. (PLATE XIII fig. 1.)

To obviate this defect, care is taken to make the sides of the redoubt a little larger, and to round all the angles in order to post infantry in them. If there be artillery, straight faces should be made upon the angles, and the batteries established upon them.

Means of obtaining fires on the capitals of any salient, by cutting the inside of the parapet in cremaillère (See *Cessac* and *St. Paul.*) (PLATE XIII, fig. 1)

As early as 1740, the directors of fortifications, Lafon and Clairac, conceived a plan of procuring fires on the capitals of the salients of a redoubt, by cutting the covering line into the cremaillère or serrated form, and making one of the teeth of each crotchet (when the redoubt is square), parallel, and the other perpendicular to the capital. If the redoubt be irregular, the tracé is modified. The ground plan of this disposition would lead us to believe that the direct fires are preserved, whilst numerous fires on the direction of the capitals are acquired by it. Indeed if we suppose the surplus thickness to be given to the parapet to form the teeth of the cremaillères, be about 8 decimètres ($2\frac{2}{3}$ feet), the teeth will be 11.3 decimètres ($3\frac{3}{4}$ feet). Therefore when the covering line AB is a right line, we have 3 direct lines of fire through the points c', a', b'. In the case of cremaillères, we may have, 1st, 3 direct lines of fire *co*, *ar*, *bq*; 2d, 2 lines of flank fire *mt* and *nx*; so that each face of the redoubt can furnish three columns of fire; one direct, and two flank columns parallel to the capitals on the right and left.

This mode, however specious at first sight, cannot stand the test of rigorous examination by the established principles of war: 1st, as respects the construction, it is impracticable; because of the workmanship that it requires, and the precision it demands, and without which it would probably be more injurious than useful: 2d, the surplus thickness given to the parapet, diminishes the interior capacity and increases the labour: 3d, the fire of the *crotchets* have not the effect that the ground plan would seem to promise: the vertical projection, and possibility of manœuvring the fires, show their real value. We must observe that the teeth of the cremaillère are in the inclined plane of the superior slope, and are consequently inclined towards the exterior. This consideration prevents us from giving to the surplus thickness more than 8 decimètres ($2\frac{3}{4}$ feet), and even by this increase it will follow, that if the breast height be correct on the direction AB, it will be too

great on CF; and if it be properly determined on CF, it will be too low on AB. In the first case, the lines of fire from the points c, m, n, and b, will not be effective; in the second case, the soldiers at m, a', and n, will not be sufficiently covered. To these defects must be added, that the lines of flank fire mt. nx, &c., have not the necessary plunge to scour to the counterscarp; they will strike the ground too far from this line. And lastly; the infantrymen at i, m, and c, cannot fire at the same time, because their arms would cross each other.

Notwithstanding these observations, this method should not be absolutely rejected; 3 or 4 cremaillères made on the right and left of the salient, may produce some effect upon the capital, and astonish the enemy who may have expected to approach with safety in this direction.

Problem, in which the relief is supposed to be 26 decimètres above the natural site (8 3-4 feet).

A salient being given, of about 70 degrees or an obtuse angle of 110 degrees, construct on the right and left of this salient cremaillère teeth furnishing fires upon the capital; and determined by the profile taken on the direction of the 4th line of fire, the point in front of the salient where this line of fire strikes the ground.

The solution of this problem will enable the students to set a proper value on this method, which is more ingenious than useful, and which we never had time to use in the various works that we have constructed in the field.

Profile of the redoubt.

The profile of the faces of a redoubt, depends on the nature of the attack to be sustained; it being the same with these works as with lines. The thickness of the parapet must be made 4 mètres ($13\frac{1}{2}$ feet), in case it is threatened to be attacked with 8 and 12 pounders.

The profiles may not be the same for all the faces.

It frequently happens that all the faces of a redoubt are not exposed to be battered by the enemy's cannon. In this case the thickness of the faces not exposed, is diminished to increase the interior capacity.

Communications of redoubts with the exterior. (Fig. 1.)

The communications of redoubts with the exterior, are made in the faces least exposed to the insults of the enemy. An opening of about 4 mètres ($13\frac{1}{2}$ feet) wide is left in the parapet, and a corresponding mass of earth is left in the ditch to serve as a bridge. This opening is closed by a barrier placed on the direction of the covering line.

Method of covering the outlet of a redoubt, by a redan or interior traverse. (Fig. 1)

As the barrier would be easily attacked, the opening is covered by a small redan, between the extremities of whose faces and the counterscarp, there is left an interval of 25 de-

cimètres ($8\frac{1}{2}$ feet). For greater security it is better to excavate all the ditch, and throw over it a small wooden bridge which is fired at the moment of attack, or the timbers of which help to fortify the opening of the passage.

When the size of the redoubt permits, we may, instead of constructing a small redan, which is liable to great objections, make an interior traverse to mask the passage. In this case it will be proper to establish two barriers between the traverse and the parapet, so that the enemy on penetrating through the great opening will find himself under three cross fires. Besides, it will be easy to barricade it with the timbers of the bridge of the ditch.

Additions to the traverse.

A small ditch may be made in front of this traverse; and above all, it must not be neglected to plant at the foot of it a strong palisading that must be enfiladed by the fire of the barriers.

Traverses made of trunks of trees, instead of earth.

Instead of making the traverse of *earth* with slopes requiring a great deal of space, it may be made of a row of trunks of trees with their lateral faces squared and placed together; and instead of a banquette to fire over the summit, loop holes (*creneaux*) may be made.

Relations that should exist between the extent and interior capacity of intrenchments, and the requisite number of men for their defence.

To discover the rules by which to judge of the relations that should connect, 1st, the extent of the covering line; 2d, the interior capacity; 3d, the number of troops required for the defence of the intrenchments; we must refer to those principles of minute tactics, which show the nature of the defence in general.

First rule of tactics.

1st. Tactics allow a front of 10 decimètres ($3\frac{1}{3}$ feet) to each infantry soldier lining an intrenchment, so that he may freely use his arms.

Second rule.

2d. One square mètre of the terra-plain of a work (about 11 square feet) is also allowed to each soldier of the corps allotted for its defence*.

* *Teilke* allows for redoubts 13 square feet for every soldier of the garrison, and 216 square feet for every gun. So that by multiplying the numbers of the garrison by 13, and the several pieces by 216, and adding these together, we find the whole interior capacity; and thence extracting the square root, we have the side of the square redoubt for any given number of men and cannon; and vice versa the number of these for any redoubt.

In sandy soils it is good to make the interior revetement of a parapet

The rules laid down for the conduct of a defence.

3d. In order that an intrenchment may be defended with the smallest number of men, it is necessary that the parapet be lined with infantry without discontinuity, and that there be a

First condition.

reserve of about one-fifth. This condition of defence gives the whole number of soldiers, when we know the number of mètres

Consequence.

in the covering line: let a be this number, and we will have for the whole number of men required $\frac{6a}{5}$.

Second condition.

But this first state of defence does not afford a fire sufficiently warm, and which can be long enough kept up; accordingly tactics prescribe that the parapet be lined with two ranks of infantry, and that there be in addition a reserve of an eighth or

Consequence.

tenth. On this supposition the number of the defendants would be given by $\frac{17a}{8}$.

Remark upon the fires.

In this second state the fire is more terrible, and the soldiers of the second rank load the arms on the slope of the banquette whilst the first rank fires.

Third and complete condition of defence.

The two degrees of defence of which we speak, relate only to the defence by fire arms. In order that the state of the defence may be complete, there must be sufficiently large corps of reserve to support the troops lining the parapet and repulse

with hurdles: to effect this, stakes are stuck in the ground and wattled together. By allowing one man to every four feet, the parapet may be thus faced in a day. In cases of great haste, stakes with branches laid loosely inside, will answer. Birch and fir branches and twigs are preferable for saucissons; and for gabions, willow, hazel, alder, birch, poplar, and beech. Two men make a gabion, whilst two collect materials; it is made in half an hour. Hurdles are generally 4 to 6 feet long, and are excellent for passing marshes, or establishing posts or batteries on swampy ground.

The works at Plattsburg, constructed in 1814 by that estimable officer Col. Totten, were in a very light sandy soil, difficult to sustain under any slope. They were first revested with branches and twigs laid in the proper slope 3 or 4 inches thick and horizontally, and maintained steady by pickets on the two faces of the epaulment and by the pressure of the earth between them. The whole was then revested with pine boards. The use of boards, especially on the exterior slopes, is not to be recommended, when *other* materials can be procured: especially if the post be liable to be attacked with cannon. Colonel Totten was forced by the want of time and other materials, to make use of them.

TRANSLATOR.

the enemy with the bayonet, and to cover the retreat of the infantry. Whenever it is possible, the numbers in reserve should equal the number of infantry lining the parapet. In this state of defence, the number of the defendants would be given by $4a$.

Consequence.

The application of these rules to extensive intrenchments or lines, is very easy. In this case it is to be observed, that no attention is to be paid to the second rule of tactics, for the terra-plain is unlimited, and the troops may manœuvre and encamp upon it in any manner that is found most convenient. It is therefore merely necessary to determine by the numbers of the troops, the condition of defence proper to be used. For instance, if a battalion of 1067 be behind a bastioned front, 550 men will line the parapets on two ranks, sustained by the remaining 517 men divided into three corps. If the battalion contain only 800 men, the reserve would be only about 300 men: and if the intrenchment is to be defended with 500 men, 300 only must line the parapet, and the other 200 remain in reserve.

Application of this, to extended works or lines.

But this is not the case in enclosed works. Here not only the extent of the line of fire in mètres should at least equal the number of infantry; but the number of men required for the defence must likewise be commodiously established on the interior of the terra-plain, and be able to there manœuvre. To fulfil this condition we must establish rules to determine the proportion that should exist between the capacity of redoubts, and the number of men required for their defence.

Application to isolated and enclosed works.

The data that we have established, and the rules of defence show, that whenever we augment the dimensions of redoubts and other enclosed works, they increase in strength. This is the consequence of the interior surface increasing in a much greater ratio than the length of the line of fire, and which, all other things being equal, gives terra-plains capable of containing the number of troops judged requisite for the maximum of defence; and beyond a certain limit, an extent of surface is obtained, part of which with respect to *quarters* is superfluous, but is a very important addition to the defence.

Strength of redoubts and other enclosed works, with respect to their capacity.

To determine what are the smallest and greatest redoubts that can be made, we must observe that the breadth of the banquette is unchangeable, and that the defect of redoubts is that no part of them are flanked: the greatest redoubt is therefore

Investigation of the limits for the dimensions of square redoubts.

that whose dimensions cannot be increased without having an interior superfluous space that will allow dispositions to produce cross and flank fires.

The smallest square redoubt, with sides of 13 mètres and defended by a garrison of 50 men.

And as the smallest redoubt should have its line of fire defended by one rank of infantry, it follows (supposing the banquette, including the slope, to be 3 mètres broad), that the redoubt with sides of 13 mètres (14¼ yards) is the smallest that can be made; for it will contain 49 square mètres (550 square feet), and will require 52 men for its defence.

Redoubt of 15 mètres, and a garrison of 80 men

A redoubt with sides of 15 mètres (16¾ yards), will have about 80 square mètres (900 square feet) of terra-plain, and require a garrison of 70 to 80 men; 60 of whom will line the parapet, and 20 will be in reserve.

The common redoubt of 20 mètres, and a garrison of 180 men

The common redoubt, is that with sides of 20 mètres (22¼ yards), and a terra-plain containing 190 square mètres (2140 square feet); it is defended by 180 men, 160 of whom line the parapet in two ranks, and 20 form the reserve. It possesses all the conditions of defence.

The redoubt of 25 mètres, and a garrison of 250 men.

A redoubt with sides of 25 mètres will have a terra-plain of 320 square mètres (3600 square feet); its banquette should be wider, and it must be defended by 250 men; 200 lining the parapets in two ranks, and 50 in reserve. This redoubt is obviously stronger than the others.

The redoubt of 40 mètres, and containing a garrison of 1000 men.

The largest sized redoubt that can be admitted, is that with sides of 40 mètres (45 yards); its terra-plain contains more than 1000 square mètres (11,200 square feet), the banquette being 4 mètres; and the garrison to line the parapet in two ranks, may be from 300 to 1000 men.

These two latter kind of redoubts have a capacity that allows of the construction of interior redoubts with trunks of trees to strengthen the defence and serve as traverses and *paradoses**.

General rules to find the side of a redoubt for a given garrison: and *vice versa*.

From what we have laid down, a general rule may be easily deduced to find the side of a redoubt for a given garrison; and, vice versa. The garrison of the smallest redoubt, is 50 men; and its sides are about 13 mètres: therefore for a garrison of 60 to 80 men, the sides should be 14 to 15 mètres.

Until the garrison exceeds 180 men, the parapet should be lined with only one rank; therefore for 80 to 180 men, the

* *Parados* is a traverse parallel to the rear of an intrenchment or battery, and to defend the rear or backs (*dos*) of the troops.

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sides must progressively increase from 15 to 20 mètres ($16\frac{2}{3}$ to $22\frac{1}{2}$ yards).

When the garrison amounts to 180 men, the parapet is to be lined by two ranks, and one eighth of the detachment to be reserved; the sides must be 20 mètres. For 180 to 250 men, the side will be increased progressively from 20 to 25 mètres ($22\frac{1}{2}$ to 28 yards).

For 250 to 350 men, the side will be increased from 25 to 32 mètres (28 to 36 yards).

And for 350 to 1000 men, the side will increase from 32 to 40 mètres (36 to 45 yards).

This latter square redoubt is the largest that can be admitted.

The reverse of the question, is very simply solved.

Strengthening redoubts.

The strength of redoubts is increased by encompassing them with trous de loup, palisadings, and abattis. The best mode of establishing palisades, is certainly by placing them in front of the counterscarp, covered by a small glacis; this is also an excellent place for fixing the abattis, and is scoured by the fires from the redoubt.

Construction of redoubts.

The construction of redoubts, is agreeably to the general modes described in the preceding chapter.

Use and advantages of redoubts.

Redoubts are much used in war; their use is to secure posts, grand guards, passes, and communications of all kinds; to defend fords, debouchès, the borders of woods, and to occupy particular positions.

Instances.

The only examples to which we will now refer, are the redoubts of Montenotte and Toulon.

The redoubts constructed at Montenotte and Toulon, assaulted.

The famous redoubt of Montenotte was garrisoned by 1500 grenadiers, and covered the centre of the French position at the opening of the first campaign in Italy, on the 20 Germinal of the 4th year (April 8, 1796). The hostile commander (General Beaulieu) intending to break the centre of the French army, caused this redoubt to be attacked on the 22d, by 12,000 men, who were during a day and night continually repulsed. This glorious and obstinate defence afforded time and opportunity to the French General, to turn the right of the hostile army and completely rout them.

The redoubt of Toulon, which was attacked by the French in 1793, covered the road in which the British fleet rode at anchor. It was defended by 1500 men, and its position was

of the greatest importance to the French. They attacked it with fury, and only succeeded in carrying it by being able to form in the ditches, which were not flanked. This last example shows that the planning of field works deserves the utmost attention, and that upon their good or bad disposition the success of operations often depends.

92. Redoubts of great dimensions, called forts or small field forts (PLATE XIII)

92. *Small field forts* (*fortins de campagne*) form a class of redoubts including many kinds of works, particularized by the nature of their tracé. What distinguishes forts from redoubts, is; 1st, the extent of the perimeter of the covering line, which is 160 mètres (180 yards) and upwards; 2d, the profile, the relief of which above the plane of site, is frequently much greater than the relief of common redoubts.

Principles that should govern in the planning of forts. (PLATE XIII, fig. 2.)

The principles that we have laid down in the preceding article and chapter, now find their application. The profiles of field forts may be the same as those of redoubts and common lines, but they have frequently a greater relief, and sometimes as much as 3.5 mètres (11 feet 9 inches); and instead of the banquettes being sloped, they may, to diminish the labour, be cut in steps when there is no rampart. The ground plan of the covering line varies according to the opinion and talents of the engineer, who should endeavour as much as possible to fulfil the conditions prescribed by the theory of defence. He must endeavour, 1st, to convert the direct fires into flank fires which take effect on the supposed directions in which the attacking columns will approach: 2d, to establish a proper relation between the extent of the covering line, the interior space, and the force of the garrison. These are the prominent properties that forts should possess: the first cannot exist in the simple common redoubts.

Chief results to be obtained by the plan of field forts.

Remarks upon the defects of redoubts.

We have already seen that the two chief inherent defects of redoubts, are; that the ditches are totally destitute of any defence; and that the approaches are only defended by direct fires, which are very slight or null upon the capitals. 'Tis to these defects that we must attribute the opinion generally entertained,—"*that redoubts are easily carried by storm; and that when the attack is conducted with talent, it is made without much loss.*" The instance referred to, of the redoubt at Toulon, and many others, show that this opinion has some foundation.

The object proposed therefore in the tracé of forts, is to obviate these two principal defects of redoubts, by taking advan-

tage of that portion of the interior space that is unnecessary for the garrison; for the redoubt of 50 mètres (56 yards) will contain more than 1500 men, and its complete garrison may be fixed at 500 men. A redoubt whose side is 150 mètres (168 yards), would contain upwards of 12,000 troops; but it does not require a garrison of more than 2000 men.

Remarks upon all the known tracés.

Of all known tracés, that with bastions is the only one that strictly fulfils the two essential conditions of which we have spoken. But if we consider the relief and dimensions that the parts of the bastioned front must have to afford a proper defence, we will be quickly convinced that this tracé cannot be executed upon a front of less than 200 mètres (224 yards); and a work of this extent, cannot be considered a *field work*. It belongs, in consequence of the magnitude of its interior capacity, the time required for its construction, &c, to the class of fortresses. Hence, all the tracés that can be adopted, only partially remedy the defects of the common redoubt.

We will now successively suppose the perimeter of different polygons to be 150 to 160 mètres (168 to 180 yards), and explain the proposed modes of fortifying them by flanking dispositions.

The triangular figure: (PLATE XIII, fig. 3.)

Let us first consider a triangular figure *ABC*; we see at once the little advantage to be derived from it; its interior capacity does not equal 550 square mètres (6116 square feet), and the salient angles are of the minimum. When local circumstances compel us to use this figure, the only remedy is to cut off or round the angles.

The triangle with half bastions. (Fig. 3.)

In some works we find the triangular form fortified with half bastions outside of the polygonal tracé. This disposition is effected by prolonging each side the quantity *Aa*, equal to one third of this side; this gives the summits of the three flanked angles. The lines of defence *aB*, &c. are then drawn to the summits of the angles of the triangle; the gorge *Ar*, is made equal to one third of the side, and the flanks *rt* are drawn perpendicular to the sides.

Examination of this tracé.

By examining the dispositions of this tracé, we find, that the salient angles are less than 60 degrees; that the flanks are so small as to furnish but an ill supported fire; that the flanks are not at all defended; and that the faces are not defended, except by a fire so oblique, that it may be considered as nugatory;

and we see that the capitals are crossed only by a very few weak fires. This method therefore must be rejected.

Of the square. (Fig. 4.)

The side of a square whose perimeter is 160 mètres (180 yards), being 40 mètres (45 yards), the redoubt constructed upon this polygon will contain 900 men; but as it requires only about 400 men to garrison it, a configuration of the covering line has been sought after, which, by diminishing the interior capacity, would give the fires a better direction.

The redoubt with tenaille sides.

The first method proposed, and which is still used, is by making each side upon the two rectangular axes MN, OP, into tenailles. The sides must be broken in such a manner, that the salient angles will not be less than 60 degrees; but then the angle of the break BFD will be found to be 150°. By this simple modification we have a fort with 4 points and 4 re-enterings.

Examination, and comments.

The angle of defence being 150°, it follows that the fires will only cross in front of the re-entering parts, and that they diverge from the capitals; since the angles RBF and BFs are, the one 30°, and the other 60°; therefore there are no cross fires upon the capitals. If to this defect be added the mischief of diminishing greatly the strength of the salient angles and the interior capacity, we must inevitably conclude that the square is preferable to the tenailled redoubt. But notwithstanding the defects of this tracé, it was used in many circumstances during the course of the last war.

The square with half bastions. (Fig. 4, *Second Part.*)

We may construct upon the square the tracé with half bastions, which offends less against the rules of defence. It will be practicable to make the flanked angles about 60°; by establishing them at this, the angle of defence Adb, will be 150°.

Examination of it.

This construction is less defective on a square, than on a triangle; but still the system is very weak. We find by examining the direction of the fires, that the faces br, &c. are (as in the triangle) without defence, and that the capitals are only crossed by very limited fires from a very small flank. A portion of the ditch in front of the branches aK, &c. is flanked; and this advantage, added to that of being able to advantageously establish batteries on the shoulder angles, are the only advantages of this tracé.

Corrections and modifications of the tracé with half bastions. (Fig. 5)

When the fort constructed upon the square is to be defended by nearly 1000 men and with artillery, the side of the polygon may be increased from 35 to 60 mètres (39 to 67 yards); and

in this case it will be practicable to advantageously modify the tracé with half bastions. After drawing the two perpendiculars or axes, and having drawn the faces of the half bastions 20 mètres (22 yards), take inside on the axis the lines *EG*, &c., of about 10 mètres (11 yards), and protract the faces *af*, &c. 20 to 25 mètres (22 to 28 yards): on the branches *Gf*, &c. let fall the flanks *GH*, &c., making the angle of defence 95° or thereabouts: lastly join the points *a* and *L*, &c. by a straight or curved face.

In this latter tracé, the arrangement of the parts is much more perfect; all the capitals are crossed by effective flank fires, and by the direct fires from the curves of the salients; the dead angles are very retired, and the greatest portions of the ditches are flanked under angles sufficiently effective; lastly, the interior space is proportioned to the strength of the garrison. A very sensible defect is however obvious; the great roundings of the salients afford shelter to considerable spaces in the ditches. This must be remedied by increasing the difficulties of scaling these parts, by secondary means, and even by *fougasses*, a kind of mine that may be very advantageously used in these kind of works*. Examination.

* *Fougasses* are made before salient angles, unflanked faces, narrow passages, and ravines, &c. to be sprung when the enemy are within 5 or 6 paces of them. The Austrians sometimes lay heavy logs and beams upon the superior slopes of parapets, or on smooth declivities, &c. to roll down upon and crush the assailants: they are called *sturmbalken*.

If the materials for a *fougasse* be ready, it may be established by 4 fatigue men and 2 carpenters in 8 or 10 hours. When fougasses are laid double or triple, they must be elongated apart at least twice their line of least resistance. If they be designed to explode all at once, one common saucisson may communicate to them by branches from a central point. If they are to be sprung one after another, the saucissons must be separated apart by several inches of earth. The saucisson contains the little trough that holds the train, laid between the mine and the spot at which the fire is applied.

When bridges are to be abandoned in retreat, these kinds of mines are made in the central or in several piers, to demolish the whole structure at a single blast. The proper use of mines and explosions, is a great auxiliary to troops on the defensive.

Sometimes when ditches are not deep, to increase the difficulties of formation in the ditch and of escalade, the bottom of the ditch is terminat-

Principles that govern the tracing of tenailles on the sides of polygons.

Thus we see that the method of tenailling the sides of a polygon, does not with the square or triangle produce satisfactory results. In order to use this mode of procuring flanking dispositions, three conditions must be fulfilled: 1st, the salient angles formed by it must be at least 60 degrees: 2d, the angle of the *break*, or of defence, must not exceed 100°: lastly, the side tenailled must be of such length, that the sides of the tenaille will afford imposing columns of fire; and the ditches must be defended in front of the salients: this length should not however exceed a certain limit, so that the fires may cross with effect upon the capitals, and that the work be not too large and out of proportion to its garrison. The limits of from 30 to 60 mètres (34 to 67 yards), have been fixed for the length of the sides that are liable to be tenailled.

Length of the sides liable to be tenailled.

Star forts.

Star forts are formed by tenailling the sides of polygons, in cases where this plan may be followed*.

Pentagons.

The pentagon is not susceptible of being fortified with tenailles, since the angles of defence would be 132°. This disposition is but of little advantage with any figure, other than the square.

Hexagons. (Fig 6)

The hexagon is the first figure that affords a result that may be admitted in certain cases. In this figure the angles of defence are 120°, and consequently the lines of fire are parallel to the capitals; this narrows very much the front destitute of fires, and makes it equal to the side of the break The perimeter must not be less than 180 to 200 mètres (200 to 225 yards).

We may break the sides interiorly, or raise an equilateral triangle on each side. In the first case, the fort will have a

ed angularly—that is, the scarp and counterscarp are prolonged to their intersection. And instead of trous de loup, we may, when pressed for time, substitute a quincunx disposition of inclined sharp-pointed stakes. Fronts may also be covered with *caltrops* or crow's feet, which are a great annoyance and defence against cavalry.—*See Teilke, and Strensle (Nicolay's translation), and other writers, on Field Fortification.*

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* *Star forts* are not a good disposition; their interior capacity is very small, and their faces may all be ricoched; and they often require more men for their defence than is compatible with their interior capacity. Their re-entering angles are all *dead*.

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terra-plain of 800 square mètres (8888 square feet), and its covering line will be 210, (235 yards); it is adapted for a demi-battalion. In the second case, the terra-plain is 3000 square mètres (33300 square feet), and the display of the parapet 360 mètres (400 yards); it is adapted for a complete battalion.

The heptagon.

What we have said with respect to the hexagon, induces an anticipation that the heptagon will furnish a more satisfactory result. And in effect, the angle of the polygon being 128°, 35′, the angle of defence will be 112°; this shows that the lines of fire will converge upon the capitals, &c.

The octagon.

The octagon, or what is the same thing, the salient-angle of 135° to 140°, affords a tracé agreeing with the principles established. The salient-angle remaining fixed at 60°, the angle of defence will not exceed 105°; the fires of the breaks therefore will cross each other effectively upon the capitals; and by a slight inclination of the fires towards the salients, the edges of the counterscarp will be enfiladed, and the bottom of the ditches fronting the salients will be flanked. The display of the directrix in the octagon, must not be less than 240 mètres (268 yards). The sides may be broken interiorly, or equilateral triangles raised on the exterior of each side; according to the interior capacity to be preserved, and the greater or less strength of the garrison. The octagon is the highest polygon that is used in field fortification. When its side is of the smallest dimension, it will contain more than 700 men; two thirds of whom line the parapet in two ranks, and the other third remain in reserve.

Of greater polygons than the octagon.

Polygons higher than the octagon, afford more advantageous tracés; and the strength of forts increases with the number of their sides. On this hypothesis the salient-angles are more than 60°, and the angles of defence remain fixed at 100°. The first are deduced from the graphical construction, by calculating from the limit of 100° for the re-entering angle.

Forts with 8 points, constructed on a square (PLATE XIII. fig. 7.)

When a fort with eight points is to be laid out, it may be done by constructing it upon a square whose sides are 60 mètres (67 yards), instead of tenailling the sides of an octagon. Let *ABCD* be the square, the display or length of whose directrix and interior capacity, are supposed to be in the relation determined by the plan of the work: draw the two axes *MN*,*OP*, on which draw the four equilateral redans *Mab*, &c. whose faces shall equal one third the side of the square; then protract inside the square the faces of the redans to the points

E,F,G,H, &c. to such a length as to reduce the salient-angles to 60°; thus making the angles of defence about 105°. This tracé is simple, and easy in practice.

Small irregular field forts.

The tracé of field forts is irregular whenever the polygon drawn upon the ground in practice is itself an irregular figure, determined by the plan of the work, and by the *coup d'œil* of the engineer. When the base is marked out, it is fortified in the various modes that we have described; the sides are tenailled, and half, and even whole bastions are constructed; and those straight or curved sides that are not susceptible of flanking dispositions, are merely profiled.

Plan of an isolated enclosed work on irregular ground: preparatory reconnaissances

The plan of an enclosed isolated work, depends on the same considerations as that of lines: 1st, On the strength of the garrison. 2d, The object to be attained by the work. 3d, The nature of the site, and influence of the surrounding ground. This plan is consequently founded upon a previous reconnaissance by which the engineer determines and establishes the polygon that is to form the base: he draws by the eye the figure of the ground, debouchès, waters, and water courses, &c.; and finally establishes the minute topography. According to these preliminary data, he marks out the principal points of the polygon on which the figure of the defences is to be established; and lastly marks them out on the ground by the common methods of geometry.

Observations.

From this brief exposition it is evident, that engineers should be constantly in the habit of viewing ground under the relations of attack and defence; in order to be able to arrange with promptness the kinds of defences which will produce those results that the general has reason to expect from the labours of the engineers.

93. Lunettes, redoubts, and flèches, used in extended systems.

93. The small enclosed works that we have been describing, are not used for the sole purpose of occupying particular isolated positions; they are frequently used in extensive systems, and in place of continuous lines which are liable to great objections. This disposition resembles that of lines with great intervals, but is superior to it; because the arrangement of all the parts is more perfect in the two-fold aspect of the independence of the parts, and the relations of defence between them.

Advantages of the system of detached works in relations of defence.

What has been said on the advantages of lines with intervals (83), will here receive immediate application; the properties of the system increase with the very nature of the works. De-

tached works leave between them intervals sufficiently large for bodies of troops to debouche through at pleasure, to attack the enemy at the moment that they are thrown into disorder by the fire of the intrenchments. They cover all the interior manœuvres, and prevent the enemy from impeding or counteracting their successive display; and these works may be erected in less than two days.

In *lines* with intervals, the gorges of the intrenchments are open, and the enemy may turn them, &c. But he does not possess this advantage in the systems of detached works; because the gorges may be intrenched so as to preserve the power of offensive returns. For this purpose, no parapets are raised upon the gorges of these works, as the enemy might avail himself of them as a cover after penetrating into them. But they are closed by strong connected palisades, with loop holes, or established against an interior banquette. Care is taken to leave an opening for a retreat, and closed by a barrier; most commonly this passage is secured by chevaux de frise or wagons or abattis. When the enemy carry a work, the gorge is battered down with cannon, and they may be attacked in it with the greatest advantage. (PLATE XIV, fig. 8.)

In the armament and arrangement of all defensive dispositions, the engineer and artillery officers should take into deep consideration *the character of the troops*. A knowledge of the human heart should not be a stranger to their profession; they should know the mighty springs that agitate mankind, and never forget, that *personal safety* is the ruling principle of all their actions; and that the bravest troops think only of self-defence when the danger is imminent. From these moral truths it follows that detached works in relations of defence, will only contribute to the common defence in proportion as their individual safety is not endangered; and that if all the works are liable to be attacked at the same time, their reciprocal protection vanishes the moment that the assault is apparent and perceived by the respective detachments. These considerations lead us to the following principle: The reciprocal protection of works; whence this is deduced.

Protection or support at the moment of the attack of the scarp and gorge of works, must be derived from dispositions in the rear not liable to attack at the same time. This proposition will hereafter be of general application; and we will now, agreea- Principle, of the relation that should exist between works.

bly to these principles, describe a system of complex detached works.

Tracé of a system of lunettes on 3 lines (PLATE XIV. fig. 8.)

To draw the tracé of a disposition of lunettes upon a given front, establish the first line of lunettes *L*, *L*, &c. the capitals of which, distant 200 to 300 mètres (221 to 335 yards), shall be at right angles to the front. Perpendiculars must then be drawn to the centre of these portions of front, and on each perpendicular lay off on the inside the quantity *EF*, equal to a little more than half of the front: this will give the lines of defence, and make the flanked angle less than 90 degrees. Take upon the capitals the parts *AB*, &c. equal to 60 mètres (67 yards), and draw through the points *B*, &c, and the flanked angles of the collateral lunettes, the lines *BA*, &c. which will be the lines of the gorges. On the lines of defence *AF*, &c. lay off *AC*, &c. about 45 mètres (50 yards) for the length of the faces measured upon the berme; and from the shoulder angles *C*, &c. draw the flanks *CD*, &c. perpendicular to the lines of the gorges.

Examination of the first disposition.

In this disposition of the lunettes of the first line, the directions of the fires are good, and the interval between two lunettes will be crossed by formidable fires; but in consequence of the distance of the capitals, they, and likewise the shoulder angles, are destitute of musketry fires; and the moment that an assault is determined, the lunettes are insulated.

Tracé of the lunettes of the second line.

In order to support and defend the lunettes of the first line from the attacks upon their counterscarps and scarps, we must (pursuant to the principles above laid down) establish a second line of lunettes, placed upon the perpendiculars and sufficiently in rear to effectually flank those on the first line, and to prevent the enemy from attacking them at the same time that he assaults the first line. To draw the tracé of this second line of lunettes, it must be observed that the faces *de*, &c. of each lunette *K* should directly flank the scarp and counterscarp of the lunettes on the first line: consequently these faces *de*, &c. established for instance at 40 mètres (45 yards), must be perpendicular to the lines of defence *FA*, &c.; and the shoulder angles *e* must be upon *AF*, and mathematically determined. To draw the tracé of the flanks, make their length about 15 mètres (17 yards), and with a radius equal to this quantity describe from the shoulder angle an arc of a circle, to which draw a tangent from the flanked angle of the second collateral lunette.

the point of contact will give the direction of the flank, and these lines of defence *g.d*, &c. will give the gorges of the lunettes of the second line.

We see by the tracé of the flanks, that they will scour in reverse the approaches of the second collateral lunettes of the first line. In practice, the flanks are drawn by laying off about 55 mètres (62 yards) upon the capitals.

Disposition of the 3d line of works.

If to obtain a greater defence and protect the second line of lunettes, a third line of works be made, they are placed upon the capitals of the first and constructed on the prolongations of the scarp lines of the second line of lunettes, which will be taken as lines of defence and gorge lines. For this purpose, flêches with faces of 30 mètres (34 yards) will answer.

Remark on the ditches.

The ditches of lunettes should be scoured by the fires of the lunettes in rear; consequently they must be prolonged on a straight line in front of the flanks, and conducted like a glacis beyond the gorge line.

The square redoubts used in extensive systems. (Fig. 9)

Square or quadrilateral redoubts are, like lunettes, used in the formation of extensive systems. But as they must flank each other, one of their diagonals must be upon the capitals; and the interior faces, instead of parapets, must be palisaded or lined with abattis, &c. The plate sufficiently illustrates the plan.

When a position, or part of it, is covered by several lines of detached works in defensive relations, it appears conformable to theory to furnish the works on the first line with pieces of small calibers and howitzers, and to make all the batteries in barbette. The heavy pieces will be placed on the barbettes of the salients in the second line, and embrasures must be made on the faces and shoulder angles to fire with grape shot along the front of the counterscarp and into the ditches of the works on the first line: the horse artillery will manœuvre in front of the intervals, and under the immediate protection of the works*.

* It was common in the French Imperial armies, to often post the artillery in the openings between the redoubts, which were only occupied with infantry. By this disposition the redoubts were better defended at the second and last period of the attack, the artillery could be *concentrated* at the most important points, and fewer cannon were required; and in the event of a retreat, the artillery might be saved. The pieces might be either on the same height, or in advance, or in rear of the redoubts; according to ground and circumstances. This disposition was used at Dresden in the

Epaulments for cavalry (Fig 10)

In continuous lines where all the ground occupied by the troops is covered by the relief of the intrenchments, the cavalry is sheltered while waiting to join in the combat. But if any commanding and adjacent height annoy the interior of the intrenchments, in this case the cavalry is uselessly exposed to the fire of the artillery, and it becomes necessary to cover them from it.

In extended systems with large intervals, in which cavalry act an important part, and sometimes even from the commencement of the battle, it is also very proper to shelter them by defences, behind which they may remain during the time that the artillery might annoy them and before required to act. These masses of earth raised upon military sites to cover cavalry, are called *epaulments;* their height and thickness at the summit is 30 decimètres (10 feet), and their length about 100 mètres (112 yards). They are placed about 200 mètres apart, and crotchets or flank returns are made to cover them from a reverse fire.

Epaulments fitted for infantry and artillery.

Epaulments for cavalry may be fitted to receive infantry and artillery; this modification fits them to protect the cavalry when repulsed and pursued, and facilitates the movements in retreat.

On top of the epaulments we may make barbettes and banquettes, affording elevated and powerful fires; and in front of the counterscarp, by lowering it 5 to 6 decimètres (20 to 24 inches) on a width of 10, we may make a small parapet, from behind which a few infantry may keep up a scouring fire very annoying to the hostile cavalry.

Comment.

Vauban frequently caused epaulments to be raised to protect cavalry in intrenched positions; the least reflection will show their great utility in all cases that cavalry is to act in a defensive attitude, in concert with artillery and infantry.

94. Application of general principles to particular cases.

94. The regular tracés that we have described, are modified in each particular case according to the topographical features of the ground, the situation in which the General finds himself,

memorable campaign of 1813, and perhaps combined with other methods. I am indebted for these particulars to that consummate engineer and distinguished officer, Lieutenant General Bernard, late of the Imperial army and Aid-de-camp to the Emperor Napoleon. The acquisition of this officer to our army, is most estimable and fortunate.

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and the time that he allows to the officers of artillery and engineers to arrange their defences. The form of each detached work yields to the nature of the site; and the defensive relations that should constitute all the parts one whole and single system, influence the form of each work, and are deduced from the nature of the front of battle.

When the front of a position runs through woods not easily defended, or stretches along their borders, or when the flank of a position rests upon woods, these cases afford an opportunity of applying the principles laid down for the formation of extended systems by detached works, abattis, &c. We may in this particular case have recourse to a system of lunettes or redoubts properly disposed, by taking advantage of the nature of the site to strengthen the works and lessen the labour.

When the front of a position runs through a wood, or along the banks of a river. (PLATE XIV, fig. 11)

A single line of lunettes or redoubts will be adequate, by eloigning them as far as 350 mètres (390 yards); and as we will be obliged to fell great quantities of trees, they must be used as abattis ranged around the counterscarps, and even uniting the works by lines of abattis placed in the rear and serving as curtains*. These abattis are covered by a slight bank of earth, like a short glacis (*glacis coupé*), as we have precedingly described. In order to uncover to a certain distance in front of the works, the trees within common musket range must be felled; taking care to leave each stump 60 centimètres (2 feet) high, and to cover the whole glade with branches. The enemy's columns will find it very difficult to make their way over ground thus broken and bristling with stumps of trees.

We must not neglect to completely clear for a sufficiently great width the terra-plain of the lines, so as to be able to manœuvre the troops and artillery. We must even open inte-

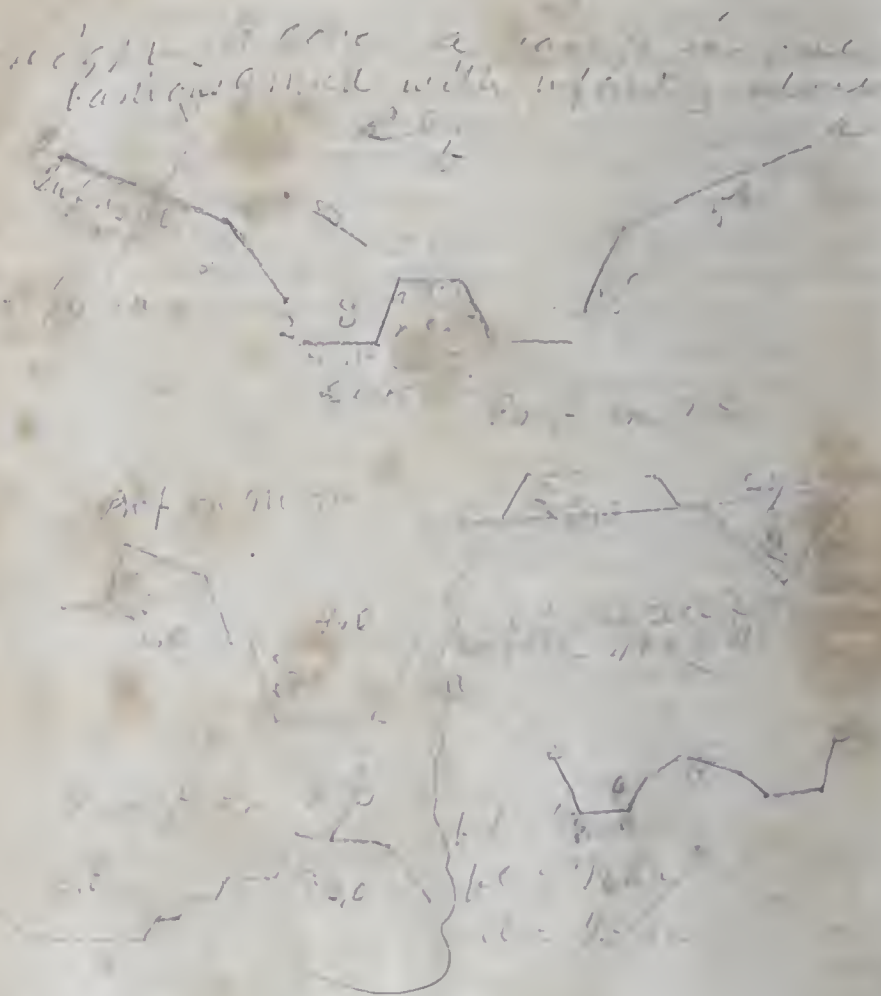
Interior passages and communications for movements in defence or retreat.

* When the ground in front of a position declines considerably, one or two rows of abattis may be made in advance of the works. These will delay the assailants and keep them more in column; and consequently afford the artillery and musketry greater powers of destruction. General Merci, at Freyburg, enveloped with abattis the foot and also the crest of the mountains on which he was encamped.

Teilke says that inclined joists or rafters, with one extremity resting upon the ground, and the other upon bags of wool or straw laid upon trestles, will resist cannon; for that the elasticity of the wool or straw, and the inclination of the joists, will cause the shot to ricochet over the heads of the men.

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rior communications, covered at proper distances with slight intrenchments; so as to be able to retreat with safety, if compelled to retrograde. Some parts of the lines on the Loutre (between Weissembourg and Lauterbourg) were *not* thus prepared in 1792; and if necessity had compelled defensive or retreating movements, the greatest difficulties would have arisen. We will not further descant on the application of these principles, but restrain ourselves within the limits of the general theory.



CHAPTER VI.

The use of Waters for the Defence of Positions, and for Strengthening Intrenchments; Permanent Field Fortification, &c.

95. AMONG the various kinds of obstacles (wherewith to fortify particular points and positions) which nature has placed within reach of engineers, the resources to be derived from water courses, lakes, ponds, and pools, must be particularly noticed. These species of obstacles, so abundantly scattered over the surface of the earth, lead to the most decisive consequences in defences, and by means the least expensive. Indeed, whenever the front of a position is covered in whole or in part by a body of water, either running or stagnant, at least 40 mètres (45 yards) wide and 15 decimètres (5 feet) deep, the intrenchments that defend the position are considered as unassailable. If the ditches of a work be filled with water 20 decimètres (6¾ feet) deep, or if the work be in the middle of a sheet of water whose depth is 15 decimètres (5 feet), it is considered as secure against assault. And if the wing of a line of battle or the flank of a position rest upon a wide and deep river, or upon an artificial inundation, that part is considered as unassailable. The engineers combine the obstacles afforded by waters, with others, to complete the projected defences. We will now consider the most general circumstances that occur in war.

95. Advantages to be derived from water courses, to defend or strengthen positions and intrenchments.

Whenever a position is covered by a river about 100 mètres wide and at least 20 decimètres deep, it is sufficiently fortified by nature; and it is merely requisite to carefully destroy all the fords, and throw up some slight intrenchments and batteries on the most accessible points, to drive away the enemy from them. In these circumstances, bridges are often established, and are covered by works; the van guard is posted in advance on the enemy's side of the river*.

Rivers that are themselves a sufficient defence.

* The great Frederick says, that a river of more than 8 German miles, is indefensible; and to secure one of this extent, there must be one or more redoubts on the bank, and the river must no where be fordable.

TRANSLATOR.

The weakness of the flanks of an army whose front is covered by a river.

We must observe, however, that an army whose front is covered by a wide and deep river, is not in consequence unassailable. Its flanks in general are not supported, and the enemy by seizing by surprise a passage across (above or below the position), may turn it, and thus render unavailing the strength of the front. Operations of this nature frequently take place in the course of a campaign, and most frequently succeed when conducted with secrecy and dispatch.

Intrenchments that should be made to guard the course of a river and dispute its passage.

When an army intends to dispute the passage of a river, it occupies one or many positions of observation on the bank *A*, whence it can rapidly march upon the points menaced by the enemy. This general disposition of the defending army shows; 1st, that the course of the river should be very closely watched by flying detachments of cavalry, infantry, and artillery, and by posts established on the most exposed points that are most favourable to the designs of the enemy: 2d, that the artillery and engineers should make dispositions on many of these points, to sustain and protect troops arriving in haste and forming to oppose the passage of the enemy. The kind of intrenchment proper for each of the guarded points, depends upon the ground; in some parts, a mere battery is sufficient; in others, a redoubt or lunette, &c. is required; and in those parts where the stream or nature of the ground favour the passage, dispositions more or less extended must be made to cover the detachments as soon as they arrive, and to preserve to each arm the means of acting against the enemy the moment that they begin to form, after having partially effected the passage.

Objects of the intrenchments.

First disposition, on a straight bank, on the concave part of a circle (PLATE XIV, fig. 1.)

If the point of passage be upon a part of the river whose course is straight, we may make a disposition whose ground plan will be the circular concavity of a segment, with a chord of about 600 mètres (670 yards), and a sagitta of 160 (178 yards): the extremes must be 40 mètres from the bank *A*. The wings in this circular disposition, must rest upon cavalry epaulments, furnished with barbettes for the horse artillery. Intervals of about 20 mètres (23 yards) must be left between the extremes of the curve and the epaulments, for the cavalry to debouche through upon the enemy, after he has received the fires of the intrenchments.

Profile of the intrenchment. (Fig. 4.)

Folard thinks that this intrenchment should be profiled with glacises or ramps on both sides, so that the cavalry may leap over the covering banks to rush to the charge. But this manœu-

vre would not be practicable. It is preferable to cause the cavalry to defile through the intervals of which we speak. This circular line will be profiled without ditches, and with interior steps (*gradins*), that the infantry may debouche from behind it in battle array.

A more simple form substituted for the part of a circle. (Fig. 2)

As it is difficult to draw a portion of a circle, we may in practice substitute for it three chords; one parallel to and within 140 mètres (156 yards) of the river, and the other two making with this very obtuse angles.

Properties of the preceding intrenchments.

The form that we have now laid down for these intrenchments, affords all the properties required by their destination. They cannot be enfiladed from points occupied by the enemy, because their wings are covered by epaulments; the fires converge upon the enemy's establishments, and scour the ground upon which they must form; and all the arms are protected by, and may debouche from behind them, in line of battle.

In case the river form a greater or less re-entering. (Fig. 3.)

The most favourable points at which to pass a river, are where the stream makes a considerable bend, convex towards the side *E*; these re-enterings, whose chords are as great as 300 mètres (900 yards), and their sagittas as much as 300 (335 yards), are favourable to the operation; they embrace a great space that the enemy may scour from all quarters with converging fires. In this case, and it frequently occurs, the intrenchments should include all the re-entering part, and assume a little convexity towards the river; but in such a manner as not to be enfiladed by any batteries that the enemy can establish.

(PLATE XIV, fig. 3.)

About 180 mètres (200 yards) from the summit of the intrenchment and on the capital of the re-entering, an advanced lunette must be established, whose faces will be flanked by the wings of the intrenchment. This work must have a communication with the intrenchments, sufficiently wide for the passage of cannon; the horse artillery will do duty in it. The wings must be terminated, as in the preceding case, by cavalry epaulments, and even by redoubts.

When there are islands.

When there are islands in the course of a river or stream that may favour the enemy, they must be occupied and intrenched, and communicated with by bridges, &c. It was in this manner that the course of the Rhine from Mayence to Worms, was guarded during the winter of 1792 and 1793.

When the volume of water is not sufficient for the defence.

When the volume of water in a river or brook is not great, and the banks are very steep and difficult of ascent, the intrenchments must be strengthened and made as near as possible to the river (to within 200 mètres (224 yards) at least), in order that the musketry fires may be effective on the opposite bank *E*. The river or brook is to be considered as an advanced ditch; and the space between it and the intrenchments, as a kind of esplanade fit for the operations of cavalry and infantry. This disposition shows, that the lines must be profiled without ditches, and that proper passages should be made for the movements of the cavalry. Whenever the course of the waters makes too great re-enterings, we must straighten the bed of the river, or establish a lunette in advance on the re-entering, &c.

When the intrenchments should be near the river banks.

When the river is eloigned more than 100 mètres from the intrenchments.

If the valley through which the waters flow, be wide, and if the intrenchments be established upon the hillocks of the side *A*, they will be almost always too far off for the musketry fires to be effective. In this case we must cut a ditch in the valley as near as possible to the lines, and distant at farthest 100 mètres (112 yards). The earth obtained by the excavation will be scattered in a glacis towards the intrenchment; and then by tranverse and irrigating ditches, water is brought into the great ditch.

Trenches or pits.

We may substitute for this great ditch, a disposition of trenches (*dispositif de criques*), or war pits. These trenches are a kind of ditch 14 decimètres ($4\frac{3}{4}$ feet) deep and 20 long ($6\frac{3}{4}$ feet), made parallel to each other and cutting the ground in checker: they are filled with water by means of irrigation, or by inundations, as we will subsequently explain.

The covering embankments are made with earth from the inside of the terra-plain, thrown up like a glacis towards the great ditch; they must be made with steps and passages for the troops to move out in battle array, to repulse the enemy when he attempts the passage of the ditch.

When the volume of water is very small

The case of a small volume of water flowing over the bed of a river or brook with very steep banks, frequently occurs, and opposes new difficulties to be overcome by the engineer. And here, what nature seems to refuse, art obtains by the mere application of that simple principle of hydrostatics, which teaches, "That any obstacles which stop the course of waters, cause "them to flow back up the river, and more or less swell the "surface, provided they be laterally confined." The artificial

Causeways, dams and dikes of inundations.

walls raised to stop the course of waters and produce a rising of the bed of the river or inundations of the valleys, are called *causeways* (*barrages*), *dams*, and *dikes* (*batardeaux et digues*).

Remarks.

The strength of the defences created by waters in the cases that we are now considering, increase in proportion as we have time and money to expend upon them. The planning and executing of such works, when the dispositions are to be permanent, require on the part of the engineer extensive practical knowledge, notwithstanding that they are to be merely of earth and wood.

Mode of overflowing or inundating the waters of a small river or creek, to make the bank *E* swampy, and cover the trenches or pits with a sheet of water.

Temporary dispositions which may be made in a short time, consist in filling with water the steep banks of the little river or brook, and overflowing with a sheet of water the ground in front of the bank *E* to cover the trenches or pits. This is effected by establishing dams or causeways at various distances, which cause a reflux and swelling of the waters. By means of these dams, made impervious to the water and capable of resisting its pressure, the bed of the river will be divided into separate basins or ponds whose waters will be at a certain mean height, depending upon the localities, and upon the disposition of the causeways or embankments. The overplus of waters must be let off by cuts made above each dam on the side *E*.

Placing the dams. (Fig. 5.)

The distance at which the dams (*batardeaux*) must be made, depends; 1st, on the slope of the bed of the river; 2d, on the height of the banks or shores above the bed; 3d, on the desired depth of water below each dam. Let *CB* be this depth = 10 decimètres ($3\frac{1}{3}$ feet), laid down upon the axis *AB* of the first dam; then if through the point *C* the horizontal *CO* be drawn, it will cut the upper bank at the point in which the axis of the next or following dam ought to be placed: the distance *AT* will be determined geometrically or arithmetically, by a proportion similar to the following: *de* = 30 centimètres : *TO* = 150 centimètres :: 100 mètres : *CO* = *x* = 500 mètres (558 yards)*.

Construction of the dams.

In field works, dams or *batardeaux* are made of earth or fascine work, or of timber. When it is desirable to preserve the means of passing over from the bank *A* to the side *E*, they are

* *de* = 30 centimètres, that is, *de* = 12 inches (nearly), the fall or descent in 335 feet (100 mètres); consequently the total fall or descent in 1675 feet (500 mètres), will be 60 inches (150 centimètres).

TRANSLATOR.

made wide enough to serve as bridges; but this is most frequently a defect of which the enemy may take advantage. It is preferable to give them the least possible width on top, and to make wooden bridges that may be burnt or destroyed at pleasure. In this case, the tops of the dams or *batardeaux* must be loaded with trunks of trees, tied together and difficult to remove: in this view, *batardeaux* made of timber are best.

Defences of the dams or batardeaux.

The *batardeaux* should be as much as possible under the full sweep of the musketry from the intrenchments; they may be covered by redans whose approaches must be defended by batteries posted in rear on the most advantageous points of the line.

Of inundations, and the means of producing them. (Fig. 6.)

Water defences assume a new degree of strength when the inundations are made in vales through which the small rivers or brooks flow, and when the breadth of these vales does not exceed 600 mètres (670 yards). This breadth in countries much broken, does not exceed generally 40 to 100 mètres (45 to 112 yards); and then the works to produce the inundation, do not require much labour or time for their construction.

To make an inundation, we must reason upon the vale enclosed between the slopes of the hillocks *A* and *E*, in the same manner as we did with respect to the bed of the river; we must imagine masses called dikes (*digues*), established at various distances, crossing the whole vale and resting upon the sides of the hillocks *A* and *E*. As it is supposed that these dikes are impervious to the water and able to resist its pressure, they will produce a reflux of the waters and an overflowing of them to a certain height; so that the course of the basin will be divided into the several lakes *A*,*B*,*C*,*D*, &c.; these will present obstacles of a very imposing kind, provided the mean depth of their waters be 15 to 18 decimètres (5 to 6 feet).

Formation of dikes; their construction and dimensions; the overfalls and sluices.

The dike or causeway to form an indundation, is always made of earth taken from the foot of the work or from the hillocks. The dike is so constructed, that the surplus waters never flow over its summit; for without this precaution it would speedily be broken down, and its destruction would be inevitable. Dikes frequently have the power of *increasing* and *decreasing the inundation* at pleasure, by means of sluices (*ecluses*) and overfalls (*deversoirs*) made in the body of the dike.

Dimensions of dikes.

The dimensions of dikes, as respects their profiles, vary ac-

cording to the height of water that they are to support, and the nature of the earths with which they are constructed.

In order to prevent filtration, we are frequently obliged to put inside the dike a mould of potter's clay well prepared (*terre glaise bien corroyée*). When the dikes are to serve as bridges to pass and repass from the bank *A* to the side *E*, they are made 4 or 5 mètres (13⅓ to 16¾ feet) thick at the summit. But in common cases and in temporary works, this thickness varies, according to the nature of the earth, from 26 to 30 decimètres (9 to 10 feet); and the slopes above and below, are made of earth under its natural slope (*terres coulantes*).

On the height to which dikes may be raised.

The higher the dikes are, the fewer are their number, the more perfect is the defence, and the more the labour is abridged But this height has limits, prescribed by the solidity of the work and confirmed by experience. Dikes cannot be often made higher than 30 decimètres (10 feet); we will adopt this as the limit.

Sluices made in the body of the dike; the placing of them.

Sluices constructed of wood work in dikes, are only used for *permanent* inundations that may be let loose or drawn off at pleasure. It is obvious that these should be placed in the bed of the river, in order to draw off all the inundations from one basin into the next, and so on to the following. Sluices are made with flood-gates (*vannes*), or with beams; the latter mode is preferable, as it is least exposed to the enemy's artillery, and by means of them we can lower the inundation any given quantity.

Overfalls to let off the excess of waters; their construction and situation.

All dikes, whether permanent or temporary, should have overfalls (*deversoirs*) for letting off the increasing waters which would otherwise swell the level of the inundation above the summit of the dike*. Each overfall should be sufficiently wide

* In permanent dams of earth, intermingle green willow twigs; in a year or two they will grow up and form a barrier or support, when the piles or walls are decayed.

A dam may sometimes be made of successive rows of stakes increasing in height from the exterior sides to the centre and wattled together, or with bundles of poles or fascines against them; and the intervals filled up with earth and stones. The stakes should be a foot apart, that is, they should recede successively one foot towards the centre; and these successive intervals should be filled with earth, stones, and fascines.

In making an inundation, the fall of the ground may be ascertained by driving into the ground stakes marked off into inches, and all whose heads are

to draw off the usual waters, as well as those produced by floods. Without this essential precaution, there is danger of the dikes being overwhelmed and even broken through by the force of the waters.

Overfalls of wood work.

Overfalls are made of wood work or of sunk stakes (*epis noyés*). Those made of wood work have their ground frames (*radiers*) 12 decimètres (4 feet) below the level of the waters, and are with single or double frames or grooves (*coulisse*), according to circumstances. The details of their construction may be deduced from the methods taught in the Lectures on the Theory and Practice of Public Works.

Overfalls of sunk stakes. (PLATE XIV, fig. 7.)

Overfalls are usually made with sunk stakes: this mode of construction is very much used along the Rhine to straighten the bends of this river, which has a constant tendency to change its bed; and it may be adopted any where that fascines can be obtained.

Construction of overfalls, when they are not upon the beds of rivers.

When the overfall is not placed on the bed of the river, its construction is easy. An opening is left in the dike of 8 to 9 mètres (9 to 10 yards) at top, but only 3 mètres (10 feet) below, in consequence of the slopes of the profiles of the dike; and in this opening the overfall is placed. It is constructed with successive layers of fascines and hurdles, filled with earth or gravel. The foundations of the sunk stakes are prolonged below the stream, in the form of a ground frame (*radier*), to prevent the undermining of the waters (*pour empecher les affouillemens.*). The pickets that fasten the layers of fascines, project out 4 decimètres (16 inches) to receive the hurdles. The successive layers of fascines cross each other at right angles, in order that all the parts may bind each other and form one mass, which experience has proved to be very durable and strong.

The top of the work, which is about 10 decimètres (3½ feet) wide, is covered with a layer of fascines, laid lengthways and strongly fastened. The slope of the side up the river, is 15 decimetres (5 feet) and is faced with sods well rooted to the

placed by means of a mason's level, in the same horizontal plane. We must begin on the high ground.

The weakest dam must be 4 feet wide at top; its slope above should be at least twice its height. Dams should be made oblique to the thread of the river, to break its force.—*See Teilke on Field Fortification: and Struensée (Nicolay's translation).* TRANSLATOR.

sides of the dike. The slope on the side down the river, is 25 decimètres (8½ feet), and is terminated by the extremities of the layers of fascines and hurdles. It is to be observed, that each component layer of the overfall should be well pinned or rooted in the sides or profiles.

Construction of overfalls on the beds of rivers

If the overfall is to be placed upon the bed of the river, its construction is more difficult, because we have to vanquish the force of the current. This is effected by throwing in bundles of fascines, ranged lengthways with the thread of the stream, until they fill up to the surface; they are then loaded, and picketed with rows of long pickets well driven. After the fascines are well piled and arranged, the hurdles are then laid on and loaded with gravel and stones. It is upon this foundation of sunk stakes, that the overfall is then constructed in the manner above described.

Placing the sluices and overfalls.

In inundations produced at the moment to cover part of a position, an intrenched camp, a line of circumvallation, or part of the circumference of a large post or station, the dikes are made of the least thickness, and no *sluices* are made on the bed of the stream. In this case, the overfall of sunk stakes or wood-work, is placed upon the very bed of the brook. But when the inundations approach the class of permanent works, that is, works which are to endure for one or more campaigns and even during peace, they are then made with much greater strength and solidity, and corresponding to the time and the money that is to be spent upon them. In this case the dikes are thicker at the top, and are considered as communications over which to pass an army to the side *E*, or to retreat behind the lines. They are provided with sluices placed upon the bed of the stream, with overfalls of a proper width. These arrangements are necessary to increase and decrease the inundation at pleasure.

Trestle bridges erected upon the sluices and overfalls.

To prevent the communication along the dike from being interrupted, a bridge is erected upon Trestles which bind the sides of the sluices and overfalls.

Works indispensable to the defence of dike heads; their figure and plan.

The heads of dikes which sustain artificial inundations, should be supported by works to defend their approaches; for they are generally too far from the intrenchments upon the side *A*, to be thence effectually defended. These heads are therefore covered by some detached work, as a lunette or redoubt.

When the nature of the ground does not permit encircling the head of a dike with a detached work, it is placed as near

it as possible, and so as to vigorously defend the approaches. Most commonly this work is a lunette, the gorge of which is provided with a connected palisading; and its ditches, and the approaches of its counterscarp, are swept in flank and rear by the intrenchments on the side *A*. When it is practicable to increase their strength by introducing 12 to 15 decimètres (4 to 5 feet) of water into the ditches of the advanced works, it must be done: they must also be surrounded by abattis, and their strength augmented by every proper secondary means.

Mode of flanking the works that defend the dike heads. (Fig. 6.)

If the width of the inundated vale eloigne the head of the dike to a distance of about 800 mètres (900 yards), the works that cover it will be ill defended by the batteries on the side *A*. In this case, in order to sweep with effective fires of even musketry the approaches of the counterscarp and ditches of the lunettes, it is easy to erect the unassailable epaulments *abc*, &c. lined with infantry, and their extremes furnished with light artillery and howitzers.

Application of permanent inundations to the defense of certain frontiers.

There are frontiers or parts of frontiers of such a nature, as to allow the use of the kind of permanent fortification of which we have been speaking, and the establishing along their whole extent of defences founded upon a system of artificial inundations, which shut them against the incursions of an enemy, protect and cover the operations of the defending army, render the attack of the frontiers very difficult although defended by a very inferior army, and afford the means of re-assembling and re-organizing the wrecks of a vanquished and retreating army. Such a frontier consists generally of a stream or large river terminating one of the flanks, whilst the other rests upon mountains from which small rivers or large brooks have their sources, and which after traversing the plain nearly parallel to the front of the frontier, empty into the river. These small rivers flow through separate vales 3 to 4 myriamètres (18⅔ to 25 miles nearly) in length, and 5 to 600 mètres (560 to 670 yards) wide; their declivity is greater or less, and the hillocks or species of counterforts which bound them, are connected with the chain of mountains and lose themselves in the general valley at a little distance from the stream. The course of the Rhine, from Strashourg to Mayence, offers a remarkable example of a similar topography. The frontier of France in this quarter, is bounded on the right by the river, and on the left by the Vosges; and from this chain descend many small

rivers, such as the Loutre, the Queich, the Spirback, and others, that empty into the Rhine. Lines, covered by artificial and permanent inundations, were constructed along these small rivers in the time of Louis XIV; and have since always been re-established at the breaking out of war. The lines on the Loutre, extend from Wessiemburg to Lauterbourg; those of the Queich, rest upon the Vosges, descend to Landau, and extend to Guermesheim. A great error was committed at the beginning of the last war in not re-establishing the lines on the Loutre, and particularly those of the Queich. Exclusive of the opinion entertained of their strength (*valuer d'opinion*), they would have obtained very great advantages for the French armies, if they had known how to defend them by able and well combined manœuvres. If during the winter that the French army spent at Mayence (1792), General Custine had intrenched Guermesheim and re-established the lines on the Queich, his retreat out of the Palatinate would have ceased at this grand and imposing position; he would have preserved the power of re-assuming the offensive to succour Mayence, and the enemy would have been kept in much greater uncertainty as to the fate of that famous siege.

If, after the reduction of Mayence, the lines on the Loutre had been found by our Generals in a complete state of defence, the enemy would not probably have been able to have forced them, and would not have pursued the French army to beneath the walls of Strasburg.

General disposition of the artillery in lines.

The works that cover the heads of dikes, should only be armed with artillery of small calibers and with howitzers; in order that they may be easily withdrawn. If a few heavy pieces be required to command distant parts, they must be placed upon the salients of the works, and should be withdrawn the moment that the enemy appear determined to assault them. These same pieces are then quickly placed in battery on the barbettes of the lines that flank the works on the side *E*. Positions in rear of the lines, should be chosen and designated for the artillery to retire upon as soon as it is discovered that the enemy have forced the lines in one or more points.

Dispositions of the army on the defensive, in rear of the lines.

The advanced guard will be posted, if practicable, in front of the works on the side *E*; but should the enemy compel this corps to retire from the field, the light infantry and artillery, supported by a few companies of grenadiers, will defend the

advanced works; whilst bodies of cavalry, followed by the horse artillery, will be in observation upon the lines to encourage and give confidence to the troops, and to charge any bodies of the enemy that may penetrate into the interior by the dikes and by crossing the inundation. As there can be no advantage, under any view, in displaying the whole army behind the lines, the body of the army will occupy a central position; from thence observe the march of the enemy's columns, and at the favourable moment put itself in motion to furiously attack them with the sword and bayonet, and drive them into the inundations. It was in this manner that the French army in 1744, manœuvred behind the lines on the Loutre. The most complete success was the reward of operations conducted with as much talents as valour. The central position, in rear of the lines, occupied by the army, should be a kind of intrenched camp, that will be of great advantage to the army on the defensive in case it is not able to repulse the enemy from the lines.

We will not further descant on these general subjects, the details of which require the particular attention and study of the officers of artillery and engineers.

CHAPTER VII.

Bridges established for an army over Rivers, Streams, and Brooks; the works called Têtes-de-Pont; the Manœuvres of an Army to effect the Passage of a River; Particular Instances, &c.

General remarks.

AMONG the various kinds of operations that take place in the course of a campaign, we must distinguish those for passing the rivers that frequently cross the direction of the line of offensive operations, or which intercept the line of march in retreat: these operations are called *the passages of streams or rivers.*

The communications established for crossing these water courses, are called *bridges and rafts.* It is the duty of the artillery and engineers to establish these communications; and the park of an army has in its train all the apparatus and materials necessary for constructing them.

96. The kinds of bridges used in war. (See *L'Aide Memoire, Foissac, & Guide de L'Officier en Campagne*)

96. In the movements of armies, bridges are constructed of various kinds, according to the nature of the water courses to be crossed. A stream is more difficult than a river; and the latter is a greater obstacle than a brook. Rafts are a very expeditious means of crossing rivers; but they are only fit for light bodies, such as an advanced guard, or detachment, &c.: a single raft is not sufficient, and commonly 2 or 3 must be united together at the same point. We do not intend to discuss this important subject at great length; we will confine ourselves to a few general explanations and applications, and refer our readers to that admirable essay on this subject in *L'Aide Memoire*, for the use of artillery officers, page 1030.

Rolling bridges.

Rolling bridges are used for passing rivers and brooks, the depth of whose waters does not exceed 20 decimètres (6¾ feet). They are a kind of wagon whose fore and after parts respectively, are composed of a sort of two-wheeled carriage, and connected together by a coupling beam which sustains all the necessary timbers and tackle for establishing the bridge. A rolling bridge displays a length of about 135 decimètres (45 feet); and *when the width of the river or brook exceeds* 150 *decimètres* (50 *feet*), *two rolling bridges are united lengthways together.*

Trestle bridges.

Trestle bridges, such as are represented in Plate XIV, fig. 7, are very often thrown across rivers of little depth and gentle current. The trestles are placed 3 mètres (10 feet) apart, and their height must never exceed 30 decimètres (10 feet). If the current be rapid, the cross-piece (*travesière*) of each trestle is furnished with a buttress or stay (*arc boutant*) moving round a pintle and armed at its extremity with an iron crow (*une pince de fer*), to sink into the bottom of the river's bed: this buttress serves as an anchor.

Description of the anchor and its use.

Anchors (whose figure is universally known), serve to fasten all the parts of a bridge of pontons or boats, and keep them steady. Without anchors the bridges would be unable to resist the force of the current; they give them a coherence and steadiness, without which, many fatal accidents would happen. The anchor is distinguished into several parts: the *shank*, a long mass of iron, constituting the length of the anchor; the *cross*, *composed of the two flukes* uniting at the shoulder; these flukes form an arc of 120°, whose centre is at $\frac{3}{8}$ of the shank, measured from the arm pit; the *claws* or *hold-fast*, being the extremities of the flukes beaten out into the form of a triangle; the *trunnions*, square pieces of iron welded upon the square of the shank, and which are set in the cheeks of the stock (*jas*); the *ring*, to which the cable is attached; and lastly the stock (*jas*), consisting of two pieces of timber fitted and joined closely together over each other by three pegs and two iron hoops. The length of the stock, is equal to the length of the shank; and the plane that cuts their axes, is perpendicular to the plane in which the shank and the flukes are situated.

We see from the figure of the anchor, that it has a tendency when under water, to gain a vertical attitude; and that one of its claws lies always against the bottom of the river, into which it sinks by its weight and the power of traction. An anchor may consequently be used as a stopping point for a floating body, attached to it by a cable.

Bridges of boats: dimensions of the boats, and their general disposition, &c.

Bridges made of boats, are used for the passage of streams and large rivers. It is easy to conceive that boats may be placed in the direction of a bridge, with their axes in the direction of the current; and then to consider these boats as trestles, and establish upon them and from one to the other, the various timbers that form a bridge. Bridges thus constructed, have the

advantage of being quickly established and removed (*replié*); and are suitable to offensive operations.

Boats, built for the bridges of which we speak, are of great dimensions, because only one bridge is erected, and over this all the columns of the army are to pass; therefore it must be wide, and capable of sustaining great weight. These boats are 130 to 180 decimètres (44 to 60 feet) long, and their width at top is about 21 decimètres (7 feet). Generally they are decked or floored two together; and in this case they are stationed twice their width apart; that is, their axes or central lines are distant from each other 64 decimètres (21½ feet). Such a bridge will sustain 12 to 15 thousand weight, and the heaviest calibers may cross over it without risk. These boats are too heavy to be carried along in the train of armies; they are built in special work shops, and transported upon carts or *haquets* to the point where the bridge is to be established.

Method of forming a bridge of boats.

The bridge is established by placing the boats successively on its direction, at the required distances; and kept steady in their respective places by anchors, lying above and below the stream, which confine them on every side. As fast as the boats are stationed, they are united together by 7 or 9 small beams which are immediately covered over by a flooring of thick planks. The first boats are fastened to the sides *A* and *E*, and they are all connected together by strong cables.

The various passages of the Rhine by the French armies in the course of the last war, were effected on these kinds of bridges, established even in the presence of the enemy: the boats were brought on *haquets* to the points designated for effecting the passage.

The permanent bridges of Khell, Manheim, and Mayence, are made of boats decked two together, and fastened to heavy anchors thrown out above and below the stream.

The bridges used by the armies in the Italian wars, to cross rivers, are constructed on boats of medium dimensions, made in that country: they are seized on various rivers, and placed in depôt in the rear of the army.

Ponton bridges; description of the ponton, &c. (PLATE XV, fig. 1)

Bridges made of pontons, are those that are generally used on rivers of gentle current, and of a width not exceeding 250 mètres (278 yards). All the apparatus, equipage, and tackling for their construction, are constantly in depôt in the grand park, and follow its movements.

The ponton is a kind of light boat composed of a frame or skeleton of seasoned elm wood, covered over with sheets of brass (*cuivre jaune*) solidly nailed upon it. It weighs about 630 k logrammes(1388 lbs. Eng.)

The ponton is composed of the following principal parts: 1st, the *gun-wales* (*plats-bords*), that form the upper surface, and on which the rows of beams rest; these gun-wales are 10 centimètres wide, by 8 thick (4 inches by $3\frac{1}{5}$), and their total length is 5 mètres .83 (19 feet 6 inches): 2d, the *front sides* (*avant bords*), the *knee pieces* (*les courbes*), the *sole* or *bottom pieces* (*semelles*), &c.: 3d, the prows or projections (*les avant becs*), &c. The following are the principal dimensions of the ponton:—

Total length.....	5 mètres	.856	(19 ft. 9 in.)
Width above the gun-wales 1	..	.060	(3 ft. 6 in.)
Length of the bottom of the ponton 4	..	.338	(14 ft. 6 in.)
Depth of the ponton 0	..	.758	(2 ft. 7 in.)

The materials and cordage requisite for forming a bridge.

To throw a ponton bridge across a river with the despatch that most military operations require, half a company of artificers or pontoniers, and about 40 or 50 common workmen, are necessary; likewise that all the tackling and implements be brought from the park to the foot of the work. These consist of: 1st, 2 trestles, about 2 mètres ($6\frac{3}{3}$ feet) high, and 6 mètres (20 feet) long; 2d, 20 shovels, and 20 mattocks; 3d, the beams, allowing 6 for each bay or ponton interval; 4th, the planks to form the flooring of the bridge; 5th, the anchors, allowing 2 for every 5 pontons; 6th, a capstan, and cable, &c.

The cinquenelle, or cable, and other fastenings.

The hawser or cable (*cinquenelle*), is a thick cable that is thrown across the river above the bridge; it is fastened on the side *E* to a heavy post or stake, and to the capstan on the side *A*. It is to this cable that all the pontons are fastened, and likewise all the anchor-cables; so that all the parts may be completely united, and kept in their places by the hold and resistance of the anchors.

Throwing a bridge of pontons. (Fig. 2.)

The first thing to be done when a ponton bridge is to be thrown across a river, is to cut ramps or a descent upon the side *A*, to put the pontons into the water; and if we are masters of the side *E*, we must send over immediately artificers with pontons, and stretch the cable (*cinquenelle*) across. The two abutments of the bridge are then established, after determining the height of the water line; if the declivity of the banks

require it, a trestle is placed before each abutment. These preparations having been made, the first ponton is placed 1 mètre .627 (5 feet 6 inches) distant from the abutment or trestle, and fastened securely to pickets planted on each shore; this bay or interval (*travée*) is then covered with 6 beams, and these with the planks. The second ponton is then placed at the same distance from the first (5 feet 6 inches), and forms the second bay or interval, which is likewise covered over with beams and planks. This work is continued from both the sides *A* and *E*. Each ponton is crossed by the beams which rest upon the adjoining gun-wale of the following ponton; their ends cover each other, and are fastened together by horizontal bolts.

As fast as the pontons are placed, they are tied together by cross fastenings, passing through the rings of the gun-wales; and the anchors are let fall above the stream, at the rate of one to every four pontons. The pontons are then fastened to the anchors, and so likewise is the cable (*cinquenelle*) if it have been practicable to stretch it across. Anchors are also cast in the stream below, allowing one anchor for 6 pontons. By these means a bridge is quickly established, even when the width of the river exceeds 200 mètres (224 yards).

Throwing a bridge across in presence of the enemy.

When we are not master of the side *E*, and cannot throw over the workmen to begin constructing the bridge from both sides, or to stretch the cinquenelle across; we must open a heavy cannonade upon the enemy to drive him from that bank, and form the bridge by degrees from the side *A* to the bank *E*, from which we must expel the enemy, in order to construct the abutment and stretch the cable over.

Time required to form a ponton bridge.

With the activity that good troops possess, it is calculated that a bridge may be established at the rate of one minute and an half per ponton; therefore as their axes are distant 3.25 mètres (10¾ feet), a bridge of 160 mètres (173 yards) will contain 46 bays or intervals, and consequently 45 pontons; and may be established in an hour and an half. Bridges made of boats, as we have already said, will sustain a load of upwards of 12,000 weight; but ponton bridges do not possess this power.

The weight that a ponton bridge will sustain.

The ponton lying as deep in the water as the water-line, which is 3 decimètres (12 inches) below the gun-wale, displaces a volume of water weighing about 2750 kilogrammes (6060 pounds Eng.). If from this we subtract the weight of the bay

or interval (*travée*), about 1200 kilogrammes (2650 pounds). we have for the weight of the load 1550 kilogrammes (3421 pounds). But as the load is distributed between two pontons, it follows that the bay or interval will sustain a load of about 7000 lbs. Eng.; and that a 16 pounder, which with its carriage weighs about 6500 lbs. (7040 lbs.), may pass over a ponton bridge by taking proper precautionary measures. The 12 pounder, the weight of which, including the carriage, is 3800 pounds (4110 lbs.), can pass without hazard.

The number of bridges required for the passage of an army, and its baggage.

When a river is to be passed by a single corps of troops, as for instance a division, one bridge only is necessary; but when it is an army and its baggage, and especially if the passage be in retreat, a single bridge is insufficient, unless it be a great bridge on boats 14 to 15 mètres ($15\frac{1}{2}$ to $16\frac{3}{4}$ yards) long. In case the bridge be of pontons, there must be two or even three, for the columns of the different arms. Care is to be taken that these bridges be so far apart, as to allow the most perfect order in the movements of the troops during such an important operation. There must be no confusion; no delay resulting from ill calculated arrangements.

97. Têtes de pont, and the dispositions of the artillery and engineers in establishing bridges.

97. An army intending to pass a stream or river, is always in one of the three following situations: 1st, the river may be free, and the enemy not in a situation to impede or disturb the passage: 2d, the reverse may be the case, and the army be obliged to force the passage in spite of the enemy: 3d, finally; the movement may be in retreat, and the operation of the passage indispensable, notwithstanding the presence of the enemy.

In the first case, the use of the bridges not being instantly required, and their preservation being of the utmost importance, they must be defended against any attempts of the enemy's detachments. The engineers will therefore take possession of the ground on the side *E*, and construct intrenchments to cover the bridges; and the artillery will concert its measures for defending these intrenchments. In both the other cases, the power and influence of the arms of artillery and fortification, are felt in a still greater degree; and without the combination of their powers, it would be difficult, and perhaps impracticable, to effect the passage of a river either in an offensive or retreating attitude.

The works constructed by engineers for the passage of a

river, are called *têtes de pont*, or bridge heads. They are of many kinds; the engineer is governed in his choice of them, by the ground and circumstances.

General form of têtes de pont; the protection that is derived from the bank *A*

We have nothing further to add upon the vertical projection or formation of the primitive profiles, which are the same for *têtes de pont*, as for enclosed works; their profiles are more or less raised, according to the intended strength and commanding nature of the work. But the horizontal projection of the directrix, is subject to a general form that should fulfil the general object proposed; and is modified by the principles that regulate the arrangement of the parts of a field intrenchment. This general form is that of a *demi-polygon*, whose gorge is the shore *E*, inaccessible to the enemy; and the wings of which should be flanked by artillery or musketry fires from the side *A*. The side *A*, constantly in possession of the defending party, must be considered as a kind of unassailable redoubt, the protection or support of which is effectual to the last moment of the contest. Accordingly *têtes de pont* may be *redans*, *lunettes*, or *horn*, or *crown works*, or a system of *detached* works. We will now examine the properties of these principal figures, considered as têtes de pont properly disposed.

Selecting the most favourable points on a river for establishing bridges.

We have seen in the preceding chapter, that all the points on the course of a river are not equally favourable for effecting a passage; those parts in which the river forms more or less considerable re-enterings, afford advantages of which we should know how to profit: 1st, the fires from the bank *A* converge on the re-entering space, and easily drive the enemy from it: 2d, the fires from this bank take in reverse the approaches of the tête de pont: 3d, the ground on the side *A* is always the highest, and commands the shore of the bend: 4th, and lastly, the defensive dispositions of the enemy upon the side *E*, are necessarily weak. When it is not in our power to establish the bridge upon a convex part of the river, we must select a spot where the river is straight; ever avoiding those parts that are concave.

The redan and lunette used as têtes de pont on rivers not exceeding 180 mètres, (200 yards) width (PLATE XV. fig. 3.)

Let us suppose that we have to cover a single bridge, thrown across a river about 150 mètres (168 yds.) wide. It is plain that the musketry fires from the side *A*, will effectually flank the work; and that the defensive polygon should be so arranged, as to take advantage of this circumstance. If therefore the tête de pont be destined for a detachment, an advanced guard,

or a small corps d'armée, its *tracé* should be that of a simple redan or lunette, with a capital of 60 to 80 mètres (67 to 89 yards), and a gorge of 100 to 120 (112 to 135 yards). Care must be taken to leave between the extremities of the faces or flanks, and the edge of the river, intervals of about 15 mètres ($16\frac{1}{2}$ yards) for the debouching of the troops and artillery, and covered by an interior traverse. If a lunette be used, its flanks must be 30 mètres (34 yards), including the intervals; and the ditches will rise into a glacis from the shoulder angles. By prolonging the faces and capital of the work, we will find upon the bank *A* the points that should be intrenched, and on which should be posted the artillery and infantry that are to flank the exterior of the works, sweep their interior, and defend the bridge.

When the width of the river exceeds 180 mètres (200 yards) (Fig. 3.)

If we consider a case where the river is more than 180 mètres (200 yards) wide, we will perceive that the musketry fires from the side *A* are no longer effectual; and that all the dispositions should be flanking batteries, composed of a great many howitzers. The redan when used as a tête de pont in this case, should be so modified as to afford musketry fires upon the capital; its dimensions must be increased, and the extremes of the faces broken into wings, flanking the approaches of the salient and its ditch. The faces may be 150 mètres (168 yards), from which 45 to 50 mètres (50 to 55 yards) will be taken to make a cremaillère crotchet of about 30 mètres (34 yards).

The redan with wings, or bonnet de prêtre covering two bridges; its properties and defects. (Fig. 4.)

When the redan is used to cover two bridges placed together, its dimensions, and those of the crotchets that form the wings, must be increased. The work is then a kind of bonnet de prêtre, whose capital is about 200 mètres (224 yards), and its gorge 360 (400 yards). The return and branch of each crotchet must be respectively 40 and 60 mètres (45 and 68 yards), including the interval of 20 mètres (22 yards). The angle of defence which the face of each crotchet forms on one side with the bank *E*, and on the other with the face of the redan, must be made of about 100 degrees.

The chief property of the redan, is that its capital and ditches are flanked by the fires from the bank *A*, and by those of the crotchets of the wings; and the enemy is seen at all the exterior points, and during the whole time of the assault. But the interior capacity of the work is very confined, and is ill suited to the manœuvres of a large corps d'armée.

Interior redoubts in earth, palisades, or trunks of trees; their relief.

Whenever a tête de pont is to make a defence of some duration, or to cover the movements of a retreat, the head of each bridge must be covered by a redoubt in the form of a small lunette or redan. It is generally made of earth; but connected palisades 20 decimètres ($6\frac{3}{4}$ feet) high, provided with an interior banquette, are preferable. Even a still better disposition may be made with the trunks of trees, instead of palisades. The profile of this redoubt should have a greater relief than the principal work, as it should command the latter by 6 to 8 decimètres (2 to $2\frac{3}{4}$ feet) when practicable.

Têtes de pont covering two bridges, and adapted to the operations of an army.

The redan and lunette, however they may be modified, are too confined for the manœuvres of an army. It is therefore necessary to substitute for the triangle, a polygonal figure of 3, 4, or even 5 sides, that will afford the advantage of greater space.

The swallow-tail bonnet de prêtre, and horn work. (Fig. 5.)

Let us now suppose that two bridges are established for the movements of the columns of an army; they should be at least 100 mètres (112 yards) distant apart, and the wings of the works should be 60 to 80 mètres (67 to 89 yards) from each bridge. These data make the gorge 260 mètres (290 yards). Now if through the extremes A and B of the gorge, we draw the two indefinite lines AX, BY, making with the bank E angles of 100° to 110 degrees at farthest; these lines will be the wings of the work. But as they will only meet at a very great distance, we must necessarily abandon the triangular figure, and substitute for it the trapezoid form, by drawing parallel to the gorge a front EF or GH, of at least 100 mètres (112 yards); and which may be as much as 250 (279 yards), if the angles of defence of the wings be nearly 90°. If the front EF be about 100 mètres (112 yards), it may be fortified in swallow-tail (*queue d'hironde*) EOF; if it be 150 to 200 mètres (168 to 225 yards), the bonnet de prêtre $ENMPF$ may be raised upon it; finally, if the front exceed 200 mètres (225 yards), it would be greatly preferable to construct upon GII a bastioned front, and add to it the redan or half moon (*demi lune*) D. This latter work is indispensable whenever an outlet or sally port (*passage de sortie*) is made in the curtain. This latter plan forms what is called a horn work (*ouvrage à corne*). When the musketry fires from the side A sweep the capitals ST, the branches may be without modification; a great opening must be left between the extremity of each wing, and the edge of the shore E.

Profile of the cremaillère crotchets that terminate the wings.

But if the fires of the side *A* be not very effectual, and this is almost always the case, each wing must be broken into one or even two cremaillère crotchets. The first crotchet must be profiled without a ditch, and with interior steps; and must have a passage for the cavalry and artillery to debouche through, to attack the enemy at the moment of the descent of the ditch, or to move forward.

The batteries and dispositions on the bank *A*, will be arranged agreeably to the principles precedingly established.

Examination of the plans constructed on the demi polygon of three sides.

The têtes de pont whose tracés we have just described, have a defect from which the redan and lunette are exempt. The approaches in advance of the front, are not flanked by the fires from the side *A*; and when the enemy is within a certain distance of the counterscarp, the front is solely dependent on its own strength. This is the reason that it must be bastioned whenever practicable, and covered by all the auxiliary means that time and the ground afford.

The great bastioned redan, called the simple crown. (Fig 5.)

When the gorge is large, say 300 to 400 mètres (335 to 445 yards), the tête de pont may be drawn in a *simple crown* (*couronne simple*). By making the capital smaller than the demi-gorge, we will have an obtuse salient angle, and a great redan whose faces will be about 200 mètres (224 yards), and which will enclose a space sufficient for the manœuvres. If then on each side of the redan we construct a bastioned front, the result will be a *simple crown*, composed of a centre bastion and two half bastions en the extremes of the wings. The interval of 30 mètres (34 yards), left between the side *E* and each half bastion, must be covered by two advanced redans (as is shown in the Plate); and the flanked angle of the centre bastion, must be surrounded and strengthened by the most suitable secondary means, and by a disposition of fougasses.

Examination of this method.

The advantages of this tracé are obvious; it possesses the chief properties of the redan, of which it is a modification. The collateral fires from the bank *A*, and of the collateral lunettes, cross each other effectively upon the approaches of the counterscarp. No one part is dependent only on its own strength; and the ditches are defended throughout their whole extent. The only important defect that can be attributed to it, is that of having a centre bastion whose flanked angle is very acute, and consequently incapable of great resistance: on

this account, therefore, we must not neglect to strengthen it by auxiliary or secondary means.

The interior redoubt may be composed of the two lunettes *R*,*R*, with the proper ditches and relief; and connected by a great obtuse redan *T*, profiled without ditches and with steps (*gradins*) inside. The interior redoubt.

The sixth figure represents the tracé that we have just described, applied to the passage of a river in front of an island that has been occupied, intrenched, and provided with batteries.

When the space that is to be enclosed by a tête de pont, is very great (intended to cover two or three bridges), and destined to protect a large army, the simple crown is inadequate. The demi-polygon in this case, is composed of 3 or 4, or even 5 sides, each of them of sufficient length to be bastioned; and the work is then called a *complex crown* (*couronne composée*). It is terminated by 2 half bastions, and contains 2 or 3 central bastions. The strength of the crown is often increased by adding great redans or half moons, placed upon the perpendicular of each front, and communicated with by bridges or by descending galleries or posterns made of wood, leading from the terra-plain to the bottom of the ditch. From the bottom of the ditch, the ascent to the terra-plain of the half moons, is by wide ramps cut in the counterscarp of their gorge. The double or complex crown work, used as a tête de pont.

Instead of using continuous works for grand têtes de pont, the ground and circumstances often render preferable a system of detached works, reciprocally flanking each other and flanked also from the side *A*. The intervals between them should be skilfully combined with relation to the manœuvres and movements of the troops. In this case it is indispensably necessary to immediately cover each bridge by redoubts, sufficiently spacious, and made of earth. Tetes de pont of detached works.

Fortresses, like Strasburg, Huninguen, Manheim, Mayence, &c., that are situated upon rivers and occupy the bank *A*, have generally permanent or field têtes de pont on the side *E*. If these têtes de pont are not kept up in time of peace, they are immediately re-established at the breaking out of hostilities. They cover the bridge of communication, and put it out of reach of insult. By means of them we possess the power of debouching into the enemy's country, of making constant incursions into it, levying contributions, and undertaking offen- Tetes de pont under fortresses.

sive operations when our preparations are completed and our army assembled. The têtes de pont of Huninguen, Khell, Cassel, &c. afforded the French army in the last war these great advantages. We will cite as an instance, the tête de pont of Cassel, the construction of which was confided to us in the winter of 1792 to 1793.

Description of the tete de pont at Cassel.(Fig 7)

This tête de pont was not in existence when the French army entered Mayence in 1792; its necessity and importance were seen and felt by General Custine. It was determined that it should be so planned, as to enable 20,000 men to fight on the position, considered as an intrenched camp; but that 3,000 men should be capable of defending it. Its gorge was fixed, according to the ground, at about 900 mètres (1,000 yards); and the general tracé was a demi-polygon, flattened, and consisting of 4 sides of about 330 mètres, (368 yards) each. Each side was bastioned, and covered by a great half-moon. This general plan produced a crown with 3 centre bastions very open and spacious, and two collateral half-bastions. The profile was a rampart 15 decimètres (5 feet) high, with ditches 28 ($9\frac{1}{2}$ feet) in depth; making a total relief of about 64 decimètres ($21\frac{1}{2}$ feet).

The right wing was directed upon the *Fort de Mars*, already constructed, and which was now armed with 10 pieces of cannon: this battery took in reverse the approaches of the bastions on the right. The left wing was directed upon the extremity of the isle St. Pierre, which was furnished with a battery of 9 pieces that flanked the bastions of the left. The plain that separated the right wing from the Fort de Mars, was crossed by 2 intrenchments *F* and *E*, profiled without ditches and with steps inside; and behind which camps were established. Lastly, the whole isle St. Pierre was fortified, and defended by several batteries.

All these dispositions formed after the first day's work, a very respectable intrenched camp. Eight battalions were employed during 4 months of a very severe winter in the construction of all the works, which were in a state of defence and armed with 90 pieces of cannon at the opening of the campaign of 1793.

The expenses of the tête de pont of Cassel, up to the period when it ceased to be regarded as a field work and was to be transformed into a more solid and permanent work, amounted

to 200,000 livres ($37,000), for more than two thousand mètres extent of intrenchments (2,250 yards) of all kinds; and including in this sum, the cost of the abattis and palisades with which Cassel was surrounded during their construction.

Every body knows that the defence of Cassel was intrusted to General Meusnier;—to that young and illustrious scholar, who brought with him into the camp the same active and inventive genius that he had displayed in the sciences. He knew how to animate the garrison of Cassel with that daring courage which each day led him to undertake brilliant enterprises, directed by a mind great in wisdom and fertile in novel resources. In pointing out this engineer as a model to the students destined for the national service, we show them the manner in which they should embellish the honourable career that is open to them for the acquisition of lasting glory.

98 Movements of armies for the passage of rivers; means used by the artillery and engineers, to second the operation.

98. The arms of artillery and engineering are in such immediate relations with the manœuvres of troops in all operations relating to the passage of rivers, that we must further illustrate this important subject (art. 97.). Passages of rivers are distinguished into two kinds—passages by *main force*, and passages by *stratagem and surprise*.

Passages by *main force* in offensive wars.

The passage by main force, is when the army on the offensive gains a position upon the bank E in spite of the efforts and opposition of the defending army. If numerous instances did not prove that this operation is practicable, we should be inclined, if we judged merely by the principles of grand tactics, not to believe in the possibility of its success. Indeed, how is it possible to persuade ourselves that an army, however numerous, can pass a river or stream upon a bridge even already established, in the presence of an army in battle array upon the side E, free in its movements, and ready to instantly attack the portions of the army that arrive upon the side E without order, or that defile over exposing their flank? The cause of this wonderful fact, is the great superiority and power of the artillery of the attacking army; and especially the moral efforts of the troops, who are inspired by a daring enthusiasm with an eager desire of achieving, in contempt of every danger, a great and brilliant action.

Passage of the Rhine by main force, and swimming, at Tolhuys, in 1672.

The French cite with pride the passage of the Rhine at Tolhuys, in 1672, in the face of the Dutch army. After driving the enemy from the opposite bank by a heavy fire of artillery,

Louis XIV beheld the French cavalry, with a daring almost incredible, precipitate themselves into the river, and locking in squadrons to resist the current, gain the enemy's shore, charge and force back the enemy, and maintain their ground 'till the completion of the bridge, over which the whole army passed in less than a day. It was the great Condé who conducted this operation with that impetuous temerity, which ever characterised him in all the scenes and dangers of war.

Passage of the Adda on the Bridge of Lodi, by *main force*, in 1796.

We will refer for a second instance of a passage by main force, to the crossing of the Adda on the bridge of Lodi, by Napoleon, in his first Italian campaign :—an astonishing enterprise, which circumstances compelled the General to attempt, and the success of which he could only expect from the devotion of the officers and troops.

General Beaulieu was in precipitate retreat, closely pursued by the French ; he crossed the Adda by the bridge of Lodi. and leaving his rear guard to defend the side *A*, put himself in battle array upon the side *E*, having his front covered with 30 pieces of artillery. The French van guard arrives at Lodi, overthrows all the outposts, and forces the enemy's rear guard to retreat. A terrible fire of artillery is then opened, and prevents the enemy from breaking down the bridge. During this cannonade, the main body of the army arrives ; and the infantry, forming into close column, present themselves before the bridge. The cavalry endeavour to ford the river. The fire is most destructive—the column for a moment hesitates ;—but it is led by intrepid Generals ; the bridge is passed with the rapidity of lightning. This impetuous column cuts Beaulieu's order of battle, and carries almost all his artillery ; dispersing in a few minutes the hostile army, and dealing death and terror on every side.

Duties of the artillery and engineers, after a passage by *main force*.

As soon as possession is gained of the side *E* by an operation of main force, the artillery repair the bridge, and establish another if necessary : whilst the engineers hastily lay out and construct the tête de pont for covering the bridges and securing possession of the side *E*.

Passages by stratagem and surprise.

In proportion as passages by main force are rare, and dangerous in execution ; so passages by stratagem and surprise, are frequent in the course of an offensive campaign, conducted with hardihood and talents. This latter operation does not require great sacrifices, or extraordinary moral efforts : secrecy, dili-

gence, good conduct, and skill in reconnaissances and in artillery and engineering, generally crown the operation with success.

We have seen (art. 95) how difficult it is for an army on the defensive to guard the course of a river, for the purpose of disputing the passage of it: it is obliged to take a central position, more or less extended, according to its force, and to only keep on the other points of the river weak detachments to watch and guard them. The army on the offensive is free in its movements, and may at pleasure draw in and concentrate; by false marches it alarms its adversary for different points, in order the better to operate upon the true point, which is thus concealed from him. This point of passage must be so chosen, that when once the operation is unmasked, the hostile army will not have time to arrive before a sufficient body of troops have passed over to keep them at bay. The operation therefore resolves itself into forcing a passage by main strength in the face of a corps of observation, which is generally not more than 2 to 3000 strong.

Manœuvres for effecting a passage by stratagem & surprise.

As soon as the General has resolved to force a passage at a designated point, a large detachment, composed of grenadiers, light infantry, light and heavy artillery, the brigades of sappers and engineers, and the bridge equipages and materials, the whole commanded by a General well acquainted with the ground, marches and arrives upon the designated spot at the first glimpse of day. A few batteries are instantly established upon the bank *A* to drive off the enemy, and immediately as many troops as possible are crossed over either in boats or by swimming or fording. These impetuously charge the enemy, and take post upon the side *E*. The engineers, sappers, and other workmen, will also cross if possible, to lay out and construct the works for covering the bridge. When the equipages arrive, the bridge is commenced; and if it have been practicable to gain possession of the side *E*, the cinquenelle (cable) will be immediately stretched across, and the bridge begun from both sides at once. When the resistance of the enemy does not allow a position to be taken in advance on the side *E*, the bridge is thrown over by main force, under protection of the artillery; but this case seldom occurs. On rivers of common width, the bridge is completed in 2 or 3 hours work; the troops then at once seize upon the side *E*.

Works used by engineers in these circumstances. (PLATE XV, fig. 8.)

The works constructed by the engineers on these occasions, should be of a nature quickly executed; they should be flanked by dispositions upon the bank A, and ought to cover the bridge in half a day's labour. It follows that the first disposition of the engineers may be a simple redan R, having the axis of the bridge for its capital, and with sides of 150 to 180 mètres (168 to 200 yards). The exterior side AB of this redan, may have one or two cremaillère crotchets. During this same time, the flanking batteries B on the side A, must be erected; likewise all the other dispositions. If the enemy be re-inforced by the alarm along his whole line of posts, and he compel the troops stationed in advance to retire, they will fall back under the protection of the fires from the side A, and of the battery which should by this time be placed upon the salient of the redan.

The whole army will march all night, to rendezvous at the point of passage. When the van guard arrives, it will pass the bridge that is already established, and take post in advance, and even attack the enemy if he persist in too closely investing the intrenchments.

Whilst the first troops are defiling, a second bridge P' is established, which will also be covered by a redan R', distant from the other 3 to 400 mètres (335 to 450 yards), and the exterior side of which ($A'B'$) will be broken into cremaillère. This second bridge must be completed before the main body and cavalry and artillery are all arrived; it will consequently be of the greatest utility.

The intermediate intrenchment, and its profile, if continuous.

The space included between the two redans, will be covered and occupied by an intermediate work G that will cover the interior debouchès and manœuvres; it must be flanked by the salients A and A' of the redans. If this intermediate work be a continuous figure, it must be profiled without ditches, and with inside steps. On the extremities of the wings there will be left intervals of 30 mètres (34 yards), for the cavalry and artillery to debouche through.

Instead of a continuous work, detached works placed in relations of defence may be preferred; the intervals between them must be considered as great debouchès through which the various corps pass to take their place in the order of battle.

Palisaded redoubts at the heads of bridges.

As fast as the army gains footing upon the side E, or marches forward, the engineers will provide against the event of a rapid

retreat, to which the army may be momentarily compelled, either by the enemy being apprised and taking measures accordingly, or by the occurrence of any other unforeseen event. These considerations render the establishment of another bridge almost always indispensable ; and lead to covering as soon as possible the head of each bridge with the redoubts *S*, *S'*, made of strong palisades joined together, and surrounded with caltrops or crows feet (*chausses trapes*) and combustible materials. We will soon find that these dispositions hold a distinguished place in the operations of a retreat, whether voluntary or forced.

Works of the engineers after passing a river.

After the passage of a river has been effected, and the army pursues its course of offensive operations, the engineers frequently regard the works that they have just executed, as *eventual works* (*ouvrages de circonstance*) which should be transformed into têtes de pont more permanently constituted, and regulated according to the relations that the army should preserve with its rear. The ponton bridge is therefore replaced by one on trestles, or made of boats of the country, in order that the pontons may follow the movements of the park ; and these works, which may be called *works of slight fortification*, are replaced by a real tête de pont : it often happens that the site of the bridge is changed.

Manœuvres of an army to effect the passage of a river in retreat, in face of the enemy. (PLATE XV, fig. 9.)

The fortune of war often compels an army to pass a river at a point where there is no bridge existing, and in the face of an enemy who has assumed the offensive. Without the combined powers of artillery and engineering, it would be difficult to accomplish an object so important, without running the greatest hazards and exposing part of the army to inevitable destruction.

Let us imagine an army of 60,000 infantry, and 10,000 cavalry ; its van guard will be 8000 strong, of whom 2000 will be cavalry.

Three bridges are judged necessary for effecting the passage in order, and without confusion. As the army is master of its rear, these three bridges will be secretly established beforehand on the proper points ; we will place them at a distance of 600 mètres (670 yards) from each other. Whilst the bridges are establishing, the bank *A* must be intrenched as usual, and provided with batteries of heavy pieces, drawn from the park at the moment that they are judged requisite. Two or three

days before the day fixed for the passage, the van guard and army will feign offensive movements; whilst 5 or 6000 workmen will be detached from the army and placed under the orders of the brigade of engineers, to make the following dispositions: 1st, the bridges must be enveloped by a first defensive enclosure (*ceinture defensive*), the wings of which must be 4 to 500 mètres (445 to 555 yards) distant from the extreme bridges; and the front 6 to 700 mètres (670 to 780 yards) from the river: this first enclosure is represented in the figure by the system of works *A* and *B'*: 2d, the first enclosure will be contracted into a second enclosure nearly concentric to it, and which may be defended with fewer troops: 3d, the bridges will be immediately covered by the redans and intermediate works that we have described; these will form the third defensive enclosure: 4th, the redans will be provided with palisaded redoubts, in proper condition; these will form the last defensive enclosure.

Manœuvres of the retreating army.

The ground having been thus prepared, or in a manner analogous to this method, the army will manœuvre in retreat with order and steadiness. During the night the heavy artillery will defile over, and take post upon the side *A*; the cavalry will also retire to beneath the first intrenchments, but always ready to move back again to the front; they will defile through the works as soon as the columns of infantry appear. At break of day the army will put itself in motion; the labouring soldiers will resume their arms and line the first defensive intrenchment, sustained by 10,000 of the first troops that enter the lines; 10,000 men will support the van guard, and 10,000 more men will line the second defensive enclosure; the remainder of the troops, that is about 40,000 men, will pass over to the side *A*. The van guard will then slowly fall back by common manœuvres upon the wings of the intrenchments, and will pass over to the side *A*; the 10,000 men by whom they were supported, will take post in the redans and intermediate works; after this the first and second enclosures will be successively abandoned, and the troops from them will pass over to the side *A*. There now remains only 10,000 men to cross. The redoubts will be occupied by companies of grenadiers, and under the protection of the redans, the intermediate works will be abandoned. Finally, the redans themselves will be abandoned. There will only then remain 6 companies of gre

nadiers, who will set fire to the rédoubts, help to *replie** the bridges, and escape over by swimming or in boats.

Such manœuvres require great ability in the General, and perfect discipline among the troops.

In the place of continuous works, systems of detached works are frequently used, and disposed in a manner adapted to the object proposed: two defensive enclosures are frequently sufficient; and sometimes only one is used, according to circumstances.

99. Instances of the passage of rivers.

99. We will conclude this chapter with a brief narration of a few particular instances of the passage of rivers; merely with a view to show the students and young officers, the manner of applying general principles to particular cases. How instructive it would be to them, and how gratifying it would be to us, if we were able to describe and analyse the principal operations of this kind that took place in the course of the last war! It would be seen that in this respect the preceding ages, and even the brilliant age of Louis XIV, present nothing comparable; and that this great improvement in the science of war, has been produced by one of those mighty causes that change the whole face of the political world. But we are destitute of the historical and topographical materials; and besides, such an extensive subject would not suit an elementary treatise, in which precepts are sought to be illustrated by only a few examples.

The different passages of the Rhine, the passage of the Adda at Lodi, of the Po beneath Placentia of the Adige at Arcola, and the passages of the Nidda, the Mayne, the Danube, the Leck, &c. constitute a galaxy of exploits that attest the valour of the French armies and the talents of their Generals. It is the province* of military history to collect all these dazzling achievements, and to draw from them inexhaustible lessons of instruction for officers of all arms.

We will restrain ourselves to quoting two famous instances;

* To *replie*, to fold up, that is, to take up the bridge by a manœuvre of conversion. To effect this, the moorings and cable are unloosened or cut, and the bridge is carried by the current down and back upon the shore *A*; for as all the fastenings are loosed or cut, except those on the side *A*, the bridge will be wheeled back upon this bank; therefore it is called a *manœuvre of conversion*.

TRANSLATOR.

the first, a passage executed by an army on the offensive; the second, a passage in retreat, executed by an army that had taken the defensive.

Passage of the Po, beneath Plaisance, the 18th Floreal year 4. (1796.) (See the Map of Italy.)

By the 15th Floreal of the 4th year (1796), the French army, impelled by the genius of its General, had conquered a portion of Italy: the battles of Montenotte, Millesimo, and Mondovi, had laid the heart of the country open to the French arms. The enemy, pursued without respite, had intrenched himself behind the Po, between the Tessina and the Sesia. The hostile General, supposing that Napoleon would move upon Valenza, fortified his camp, and covered Pavia with formidable redoubts. The enemy was kept in this delusion by several feigned and able movements. On a sudden, by a rapid night march, 5000 grenadiers, 1500 cavalry, and the artillery and engineers, moved along the right bank of the river, and by break of day arrived opposite Placentia. During the night, all the boats upon the Po had been seized; the troops cross to the enemy's side of the river, and overthrow all the hostile detachments that attempt to dispute the passage. The General commanding the artillery causes a bridge of boats to be thrown across the river; and the army, which had marched by echellons of divisions, crossed during the day of the 18th. The chief of the engineers covered the bridge by an intrenchment, the form of which was determined by the ground; an old dike running parallel at 150 mètres (168 yards) from the bank *E*, was arranged as an intermediate intrenchment, and flanked by two redoubts which formed the wings of the tête de pont.

The passage of the whole army was effected before General Beaulieu could arrive with his army on the point of passage. By this able manœuvre, the French General placed himself in the most advantageous position; after turning the positions of the enemy, and his intrenched camp under Pavia, he found himself upon the flank of the enemy's line of operations. General Beaulieu now determined to march against Napoleon; he seizes, and intrenches himself on, the position of Fombio. The battle commences; the enemy is forced from his position, and compelled to retreat by Lodi to behind the Adda. It was after, and in consequence of this battle, that the celebrated passage of the Bridge of Lodi was achieved*.

* On passing the Moldau on the 5th May, 1757, just below Prague and the day previous to the battle, the great Frederick caused three

Passage of the Rhine in retreat at Nordheim by the French army in 1744 (See PLATE XXXIV of the 2d volume of St. Paul's work.)

Of all the instances of the passage of rivers, by a retreating army in the presence of an enemy acting on the offensive, considered under the relations of the influence of artillery and engineering, the most distinguished is the passage of the Rhine at Nordheim, below Worms, by the French army in 1744. The Prince of Conti, General of the French forces, wishing to withdraw his army from the right, to the left bank of the Rhine, in the presence of the enemy who had assumed the offensive, selected the position of Nordheim, below Worms, for the point of passage. He therefore made the necessary detachments to Nordheim, to make the following dispositions; 1st, 2 bridges were thrown over behind Nordheim, and covered by a grand tête de pont; 2d, 5 redoubts, skilfully disposed in echellons, were erected on the plain between the tête de pont and the village of Nordheim, distant 8 to 900 mètres (890 to 1000 yards) from the shore *E*; 3d, the village of Nordheim was intrenched; 4th and lastly, the front of the camp, situated behind the village of Bobstatt, was covered by detached redans; the right rested upon morasses, and the left upon a small river.

guns to be fired, to apprize Marshal Schwerin, who was with his corps d'armée at Brandies, that the King had effected the passage and that the Marshal should accordingly fall back from the Elbe and join him. This junction took place under Prague at midnight.—*See Jomini, Part I.*

Bridges are passed with great care—the cavalry dismount and lead their horses across on a gentle walk; the wagons are lightened, if there be time; and every precaution is taken to prevent violent shocks and strainings that might break or injure the bridges. When the enemy possess the *upper* part of the river and its current is rapid, booms and piles and piers, &c. should be established to prevent any rafts or timbers, &c. that the enemy may launch against the bridges, from carrying them away. The swelling of the rivers must be provided against. In the battle of Essling, which preceded that of Wagram, the French army was insulated in two corps and exposed to utter destruction by the loss of their bridges across the Danube, occasioned by the swelling of the stream and drifting logs and trees. The horrors of the bridge of Beresina, will be remembered in history. And the passage of this river between two superior armies, one pursuing, and the other disputing the passage, is an achievement almost surpassing mortality. It is by strokes like these, that an empire is saved, and that human genius triumphs over mortal force.

TRANSLATOR.

The village of Bobstatt was to be occupied by the van guard. These general dispositions presented the army with a series of concentric fields of battle, constantly narrowing; and by means of which, the General could, by successive and well executed manœuvres, defile all his divisions without danger. At break of day the army evacuated its camp; 25,000 men remaining in Nordheim to sustain the rear guard. These 25,000 men then retired under the protection of the 5 redoubts, which were defended by 10,000 troops, who retired in succession into the tête de pont, which was also evacuated upon the interior redoubts, &c. The skill and order with which these movements were executed, prevented the army from being annoyed during their operation. This retreat is worthy of being held up as a model in all similar cases.

CHAPTER VIII.

Posts, and Intrenched Camps.

100. AN army taking military possession of a country to there carry on offensive operations, maintain itself upon the defensive, or to repose in winter cantonments, but ever ready to re-assemble in a body, should take possession of the villages, hamlets, castles, mills, country seats, farm-houses, &c. that are within the scope of its front and flanks, or upon its communications; or which are upon the line of defence of the cantonments. These various points are occupied by detachments, and are called *military posts.* These posts are in relations of defence with the principal positions to which they are subordinate, or with each other to form a system of defence; or they are isolated and dependent entirely on themselves; for instance, posts that protect the communications and annoy those of the enemy, &c. are of this character.

100. Posts held by an army in the field, and in winter quarters. (Study *Le Guide de L'Officier en Campagne*, by Cessac: and read Folard and Clairac.)

The subjects discussed in the First Part, have taught us to appreciate the importance of posts, and the advantages to be derived from their proper disposition, and the more or less obstinate defence that the detachments may make in them. In the sketch of the last campaign of Turenne (66), there are two or three striking instances of this kind.

Necessity of properly fortifying and establishing military posts.

If Marshal Villars at the battle of Malplaquet, had seized the farm that was in front of his line of battle, Prince Eugene would not have been able to have obtained such great advantages over him. If the heights that covered Bingen had been intrenched and covered with abattis, as the engineers had recommended, General Custine would not have suffered those dreadful disasters which forced him to a precipitate retreat.

These reflections lead us to conclude, that military posts should be properly intrenched; and that the species of fortification proper for this circumstance, is a necessary acquirement for every officer, whatever may be his arm or corps. The officers of the light troops, who are always at the outposts and penetrate on all sides into the enemy's country, are continually in need of having recourse to the means of intrenching them-

The officers of the line should at least know the theory and details of the fortification of posts.

selves in a church, a castle, or a house. The officer of the line who is about to occupy a military post, should first devote his attention to the means of preventing himself from being carried off, before succour can arrive; he must intrench himself immediately, and never rest 'till he has completed the dispositions for the defence and safety of his detachment. In this respect numberless disasters occur in war, which should be entirely attributed to the ignorance of the infantry officers of field fortification, and of the methods of temporarily defending posts. How desirable it is, that young officers should keep constantly in mind the example of Marshal de Saxe, who though attacked in an inn by 200 dragoons and upwards of 500 Polish horse, knew how to defend himself and repulse them by defensive dispositions, notwithstanding he had only 18 men! Likewise that they should read Folard's interesting descriptions of the defence of posts. They would soon be convinced, that they should in time of peace instruct themselves in all the branches of the noble profession that they have embraced. It is true that the engineer officers who follow an army, are charged with establishing all the defences; but they are never sufficiently numerous to attend to all the posts, and can only give attention to works of a certain character and strength. They must therefore restrain themselves to giving the officers of the line a few instructions, which cannot be understood if these officers have not gone through preliminary studies, and have no knowledge of drawing.

Various kinds of posts, and the manner of considering them.

Military posts are of infinite variety, according to the object to be attained by them, and the particular importance to be given to the site that they occupy. If a village, hamlet, or farm, &c. lie upon the front of a position or a little in advance, or upon one of its flanks, it must be intrenched; but these intrenchments must be open at the gorge, which should be prepared accordingly. Posts of this kind, are intrenched on the same principles as a continuous line, and according to the general theory that we have laid down. If the village or farm, &c. be inside, they may be surrounded by intrenchments that will serve as a grand redoubt, to cover the movements in rear or of a retreat, and facilitate offensive returns. But if the post be distant from any position occupied by troops; if it be put in a state of defence like those occupied by van guards or a flanking corps; if it cover a communication; if it be situated

upon one of the enemy's communications; or finally, if it make part of a system of cantonments; the defence of such a post must rest upon its own strength, as it is exposed to be surrounded on all sides, and must defend every point of its perimeter. The general plan for such a post, is that of a great enclosed isolated work, or that of a system continuous, or interrupted, and the directrix of which will be a polygon enclosing the space that the post is to occupy. It follows from this general view, that all the principles we have laid down directly apply to the case in question.

The interior or defensive redoubt that should be inside all important posts.

We have already remarked (78) how important it is to making a good defence behind intrenchments or enclosed works, to have an interior redoubt to sustain the confidence and courage of the troops, and produce the most obstinate defence. This general principle has a direct application to military posts, where frequently the defensive redoubt opposes a longer and more brilliant defence than the exterior polygon. The necessity of such a redoubt will be powerfully felt, by considering that the parts of the exterior polygon have but an exterior relation; and that the moment one of these points is forced, all the others are taken in reverse, and necessarily fall into the hands of the enemy. It is requisite therefore that all the troops should be able to retreat to a central point, on which to renew the action and give time for succours to arrive, or to obtain an honourable capitulation.

Probable duration of the defence of intrenched posts.

The duration of the defence of intrenched posts, cannot be long; if they resist half a day, or a whole day, to afford the succours time to arrive, 'tis as much as can be expected. The thunder of the attack and the concerted signals*, give notice to

* These signals are a fixed number of guns, rockets or beacons, &c. Beacons are established upon the peaks of mountains or heights; sometimes there is a chain of them, communicating the alarm along a whole frontier or coast. The modern invention of telegraphs, is admirable for these purposes.

The following are the combustible materials for a beacon: a barrel of pitch, melted over a moderate charcoal fire, with one ounce of rape seed oil, half an ounce of gunpowder, and half a drachm of powdered brimstone, to every pound of pitch; the whole well melted and mixed together: as much hemp or tow as will make the composition consistent, will then be thrown in and stirred. The hemp will be at the surface.

This composition is then put into a barrel, with mealed powder scattered

the nearest troops of the post being attacked, and that it is in need of succour. If the succours arrive, the enemy will be obliged to retreat; if the detachment be left to its fate, it may capitulate after having exhausted all its resources and means of defence.

Frequently a post, defended with vigour, prevents the defeat of a corps d'armée and compels the enemy to renounce his schemes of offence. The post of Wervike, situated on the Lys, above Menin, by a vigorous resistance on the 10th September, 1793, saved the Dutch army from total destruction. The post of Turcoin, by an obstinate defence, arrested for nearly a whole day the progress of Lille's division, which was moving upon the camp of Menin (July, 1793); and this single event rendered necessary a change in the plan of attacking the English army. More ample illustrations by particular cases, would lead us beyond those limits that we must observe. What we shall say on this important subject, will serve as an introduction to those works in which it is treated with more amplitude and ingenuity. De Cessac, in his *Officer's Guide in the Field*, has left nothing more to be desired by young officers on the fortification of posts, and their attack and defence; and by the numerous and varied quotations with which this author has illustrated his work, he accomplishes the double and rare advantage of instructing young officers of all arms, and at the same time cherishing in them the love of glory and country.

The elements that are used in the disposition of the intrenchments of fortified posts.

The elements composing the *material* organization of the defence of posts, are: 1st. All the various obstacles that we have used in the composition of field intrenchments; that is, earth parapets, ditches, palisades, trunks of trees, abattis, chevaux-de-frise, barriers, war-pits or trous de loup, dams, sunk-stakes, sluices, dikes, and batteries of all kinds: 2d. Walls and hedges adapted for musketry, *tambours* of frame work, barricades, and machicoulis. We have nothing to add with respect to the elements of the first class; we will now succinctly describe those of the second.

Hedges, even in their natural state, have ever been consider-

over it, and a quick match communicating to it through a small saucisson or tube. The top of the barrel must have air-holes, to ensure conflagration; and the whole will be well secured from the weather by a case or thatch, &c. *See Teilke on Field Fortification.*

TRANSLATOR.

ed as an excellent defence for infantry; and when a regiment is charged with the defence of a village, it occupies the hedges, orchards, and gardens, which serve as an intrenchment. When time is allowed to arrange these hedges in the most advantageous manner, they must undergo some preparations, which, though slight, greatly increase their strength: 1st, We must pluck up and destroy all the hedges that are thin set ("*peu garnies*") and ill situated with respect to the exterior direction of the fires; in order that the others may form a system whose parts are flanked. 2nd, The hedges must be examined with respect to their *relief;* if their height exceed 20 to 25 decimètres ($6\frac{3}{4}$ to $8\frac{1}{2}$ feet), they must be cut down to this height with the instruments found among the peasantry. A small exterior ditch must then be made, and the earth from it thrown inside to form a banquette; taking care to lay a thickness of a foot of earth inside against the hedge, to resist balls. When we have not time to dig an exterior ditch, the banquette is made by taking earth from the interior. If the hedge be only about 12 decimètres (4 feet) high, the exterior ditch becomes the more necessary, in order to have a height of 20 decimètres ($6\frac{3}{4}$ feet); and that the troops may be under cover behind the hedge, a terra-plain must be sunk inside, as is shown in fig. 2.

Method of fitting hedges for defence (PLATE XVI, figs. 1 and 2)

Walls, whether of enclosures or buildings, like hedges form an excellent defence when properly situated; and are susceptible of preparations according to their construction.

Manner of fitting walls for defence.

When a wall is high (*couvrant*), and at least 20 decimètres ($6\frac{3}{4}$ feet), we may, in consequence of the tenacity of the materials with which it is constructed, make in it in a very few minutes a disposition of loop holes (*créneaux*) on one or two stories, which will make the approaches to it very dangerous.

Making loop holes in a high wall.

The walls in which loop-holes are generally made, are of a mean thickness of 70 centimètres ($2\frac{1}{3}$ feet); these are a kind of aperture whose ground plan *C*, *C*, &c. is a trapezoid. The exterior opening is only 10 centimètres (4 inches) wide, whilst that of the interior is 60 centimètres by 70, in thickness (2 by $2\frac{1}{3}$ feet): This latter dimension increases or diminishes in the same ratio as the thickness of the wall. The profile or vertical projection, is also a trapezoid, the interior height of which is about 40 centimètres (16 inches), and the exterior 50 (20 inches); this gives the bottom of the loop-hole a proper slope. The centre lines of these loop-holes, are 10 decimètres ($3\frac{1}{3}$ feet) from each other.

Description of the loop hole; its tracé. (PLATE XVI, fig. 3)

Speedy method of making loop-holes.

When walls are made of rough stones and with lime and sand, the loop-holes are easily made, and without danger of the wall giving away. But the greater part of walls in the country, are made of clay mortar; and in this case the demolitions must be made with caution. We can very quickly make a loop-hole when we have (which is almost always the case) old timbers (*bois de demolitions*). Take four ends of sleepers *a*, *b*, *c*, *d*, of the height of the loop-hole and about 15 centimètres (6 inches) square, and place them in the square apertures *c*, *d*, as is shown in the figure.

Method of preparing a wall destined to be defended by musketry. (Fig. 4.)

Let us now examine the profile of the disposition of a defensive wall; remembering that the breast height must not exceed 140 centimètres ($4\frac{2}{3}$ feet). If the wall *M* be only 150 centimètres (5 feet) high, the top of it *H* must be cut down to the height of 140 centimètres, and the fire will be over it; the natural ground *B* serving as a banquette. In this case, it will be necessary to excavate a small exterior ditch *F*, about 80 centimètres ($2\frac{3}{4}$ feet) deep. Inside, an artificial terra-plain *K* will be dug; preserving the banquette *B*, 69 centimètres ($2\frac{1}{4}$ feet) wide; the lower and *rasant* loop-holes *D*, *D*, &c. will then be pierced, and through these the soldiers will fire from the terra-plain, standing between the intervals of the first rank.

(Figure 5.)

If the wall be 25 to 30 decimètres ($8\frac{1}{2}$ to 10 feet) high, it may be cut down as far as *H'*, to fire over it by means of the banquette *B*; or it may be pierced with an upper row of loop-holes *C*. There will be then made, as in the first case, a lower tier of loop-holes *D*, through which to fire from the terra-plain *K*: the exterior ditch *F* may be dispensed with.

Barricades.

The barricades made use of in the defence of military posts, consist in closing up the openings, communications, gates, passages, &c.; so that the enemy will be stopped at them, and will not be able to rush in through these openings. For this purpose there are used; 1st, layers of beams crossing each other at right angles and forming a species of caissons, that are successively filled with earth: 2nd, carts and wagons, sunk into the earth up to their axle-trees, and filled with earth and stones, &c.

Tambours of wood. (Fig. 6)

Tambours of timber, are the best means of giving to slight fortifications the properties determined by the principles of defence. By means of tambours well laid out and arranged with skill, flank fires are obtained; and by a little labour, all the

parts of a wall may be made to flank and reciprocally protect each other. Tambours are principally used for covering the gates or openings which preserve the exterior relations. The tracé of a tambour, is like a redan or lunette, &c., the sides and angles of which vary according to the ground. For instance, let OMN be a wall in which the gate P has been made; it is obvious that the part MN, and the gate P, are ill defended. But if upon the capital AB, we construct the tambour T of timber, in the form of a lunette, we will have a disposition of fires incomparably more advantageous; and the part at the gate that was the weakest, becomes the strongest, and protects all the other parts, whilst they protect it.

Construction of the frame tambour.

Tambours of wood, are made of joists 32 decimèters ($10\frac{3}{4}$ feet) long, and 15 centimètres by 15 square (6 inches by 6); they are planted perpendicularly in the ground, like palisades, care being taken to set them perfectly close together; their height above ground is 25 decimètres ($8\frac{1}{2}$ feet). Two tier of loop-holes are then made in the faces of the tambour; the one 14 decimètres high ($4\frac{2}{3}$ feet), and the other even with the ground, in which the banquette is sunk; or else the first tier of loop-holes is at a height of 20 decimètres ($6\frac{3}{4}$ feet), and a banquette is made inside with planks, &c.; and the second tier is made at an elevation of 8 to 10 decimètres ($2\frac{3}{4}$ to $3\frac{1}{3}$ feet). Generally a ditch is made in front of tambours, sufficiently deep to prevent the enemy from reaching the upper and even under loop-holes: on this account the second disposition of loop-holes is most advantageous. Tambours are commonly covered by a kind of shed or pentice made of small beams close together, or of many layers of planks, making a thickness of at least 12 centimètres (5 inches), so as to be shielded from grenades.

Machicoulis, & interior large loop-holes.

Machicoulis, of which we shall speak fully in the Third Part, are used in slight fortifications to defend the foot of the walls of lofty edifices which the direct fires but very feebly defend: and thus prevent the possibility of the enemy sapping or breaking through them. Machicoulis consist in making on the top of the wall of a building, such as a lofty house, a church, a castle, or steeple, an exterior gallery projecting out about 10 decimètres ($3\frac{1}{3}$ feet), floored with boards at least 12 centimètres (5 inches) thick, and covered throughout its whole extent with planks of the same dimensions. It is not necessary to make this kind of parapet more than 18 decimètres (6 feet)

high. Loop holes are cut in the parapet, and large loop holes (*meurtrieres*, murderers), are made in the flooring through which paving stones, grenades, &c. are thrown upon the enemy when they present themselves at the foot of the walls.

These large interior loop holes (*meurtrieres*) are made in the floors of the upper stories of a house or castle, to defend the entrance of the doors of the lower stories, and destroy the enemy when they penetrate to it. This method was used by Count de Saxe in his defence of the inn of the town of Crachnitk, in Poland.

Remarks upon the positive strength of the means described.

These elements of slight fortification, are only capable of resisting musketry and the physical strength of men. When the question is to resist artillery, the arrangement of the relief necessarily varies; all the coverings must then be strongly terraced, and loop holes, machicoulis, &c. are of no use; and we must consequently return to works of the first class.

General dispositions or the defence of a post of importance.

When the General has determined to occupy and intrench a post, he gives his instructions accordingly to the officer of engineers who is charged with establishing the defences, as well as to the commandant of the detachment that is to defend the post. The instructions to the officer of engineers, state, the strength of the detachment, the degree of resistance that the post should possess, the succours that may be expected, whether artillery is to aid in the defence, and if so, how many pieces; and lastly, the time and expense are prescribed.

The seizing of a post, and the preliminary operations and reconnaissances of the engineer.

The commandant and engineer are no sooner within sight of the post, than they must reconnoitre it under a military aspect, and instantly cause it to be occupied by the detachment. They will take all necessary precautions against the inhabitants, to prevent the enemy from gaining intelligence before they have time to properly establish themselves. All the avenues will be occupied. guards and outposts established, &c.; all the outlets must be barricaded, and only one or two passages kept for communicating with the exterior. The adjacent houses that may impede or annoy the defence, are burnt or thrown drown; and the entrances are provisionally closed with wagons or abattis; and epaulments are speedily erected for posting the artillery (if there be any) on the avenues most favourable to the enemy's approach. Finally, all the peasants who can be collected, are employed in removing the hedges that are in the way, and filling up the ditches. In 3 hours

these preliminary preparations will be in full activity ; and the engineer will begin to make reconnaissances of the site in relation to the defences that he is charged to establish.

Defences of small posts, including country-seats, houses, mills, farms, castles, &c.

If the post to be fortified is intended only for a small detachment, and consists merely of a house, a castle, or a farm and its dependencies, &c. it will be prepared to resist infantry only. There will accordingly be employed in the composition of its defences, only elements of the second class, relating to slight fortification. On this hypothesis, the engineer will make a rough draught of the plan of defence, which he will deliver to the commandant of the post, accompanied by an explanatory memoir showing the resources for the construction, and the means of executing it. It will then be the duty of this officer to cause all the works of the defences to be executed ; his chief attention should be directed to establish in rear of the dispositions, a perfect freedom and facility of movement.

Defences of large posts.

But if the post be a village, a borough or small town, or an important position ; if artillery is to co-operate in its defence, and the detachment be proportioned to the extent of the position ; the defences in this case assume a more imposing character, and the officer of engineers must remain at the post to superintend and regulate the execution of the works.

Reconnaissances for the interior redoubt; its choice and preparation

In this latter case, the reconnaissance is more complex, and is completed by several successive operations. After the first general precautions which we have just described, are taken, the engineer and commandant will determine on what part of the interior of the post the *defensive redoubt* should be established. They will fix upon a church with its burying ground, or a castle or a large house and its out-buildings, or upon a system of houses. The selection being made, the redoubt must be entirely isolated ; all the houses that overlook it within musket range, must be demolished or burnt down, as likewise all those that are too near and mask the approaches.

Convenient communications will be opened from the redoubt to all the exterior points. This redoubt is as it were the heart of the defences, giving life and succour to all the extreme parts. It will be considered as the *place of arms* and general rendezvous, and must be immediately arranged and prepared by combining together the elements of the second class.

Reconnaissances for the polygon of the exterior defences.

Whilst the engineer is engaged in these first important details, he must not lose sight of his principal object; he will

reconnoitre the site, to determine the polygon upon which the disposition of the exterior defences should rest. He will carefully survey all the environs of the site, and make a rough draught or plan of its topography. He will not only examine the figure and variations of the site upon which the defences are to be erected, but also the influence that the surrounding ground may possess from its configuration, the debouchès that it affords, and the advantages that the enemy may derive from it. The result of this reconnaissance, is the establishing of the defensive polygon that is to envelope the position, and of the detached works that are to be erected in advance to occupy the most commanding points. All the obstacles and exterior coverts of the polygon, such as hedges, ditches, houses, walls, ravines, &c., will then be razed and levelled.

Form and nature of the intrenchments of the exterior polygon; positive and relative strength of the different points of its circumference.

The intrenchments of the defensive polygon, will be formed of elements of the first class; their profiles will depend upon the nature of the attack that they are to resist. The ground plan will be a continuous system, or detached works in relations of defence, or a mixed system; so that the combined elements will produce at the different points, a maximum of positive and relative strength.

Accidents of ground; to reduce the assailable points to the smallest number.

If the site afford no resources in waters, woods, declivities, morasses and other features, the natural position will be too weak in itself; and art can never make but a very bad post of it. It should therefore, in this case, be abandoned; or if it be fortified, the strength of all the points of the perimeter, must be in equilibrium. Generally, however, the positions marked out for posts afford some resources in the way of natural varieties of ground; and of these the engineer should take the utmost advantage, to render some parts of the circumference unassailable. He must endeavour to support the greatest part of the defensive polygon by a river, an inundation, a natural or artificial morass, declivities, &c.; he will then have to intrench only two or three assailable points, upon which he will display all the means that nature and art have put in his power.

Recapitulation of the general principles that must govern in the general arrangement of works.

In the general disposition of the works composing the defences of a large post, we must never lose sight of the following principles; 1st, The effective range of the arms: 2d, The effective direction of the fires: 3d, The relation that should exist between the works, in which must be observed the laws of flanking and of mutually supporting works: 4th, Lastly,

the establishment of the defensive redoubt, to cover the retreat or obtain an honourable capitulation, if the succours do not arrive in time.

That part of instruction which relates to posts, should be completed by applying general principles to numerous particular cases, on the two suppositions, 1st, of a post slightly fortified; 2nd, of an important post, capable of a vigorous resistance. But these details would lead us too far; they shall be given and treated in the oral course. The students and young officers may exercise themselves by making plans for particular sites, extracted from the topographical maps*. They must study with attention the precepts of Folard, on the defence of houses, castles, &c.; and examine with care the particular cases treated in the works of those officers who have written on temporary fortification. We will restrain ourselves to presenting a single example, exhibiting a system of all the works that can be used in an intrenched post.

Application of general principles to particular cases. (See Folard's Commentaries; the Officer's Guide, by Cessac, the War of Intrenchments, by Foissac; and the Treatise by St. Paul.) (PLATE XVI.)

The church yard and church R, form the interior redoubt, to protect the retreat which may be effected by the bridge P: r, r, &c. are tambours of trunks of trees, defending the approaches of the church yard. All the exterior hedges and houses serve as curtains to flank the advanced works, which are themselves in the most intimate relations of defence, and have direct communications with the redoubt R. Lastly, the commanding mountain M, is strongly occupied. The study of the plate will sufficiently show the reason of all the dispositions; and the intelligence of the student will supply those details that cannot be explained on so small a scale.

101. Intrenched camps are distinguished into three kinds. The first includes all large posts established on uninhabited positions, and on which the troops charged with the defence en-

101. Intrenched camps, and their properties. First kind of intrenched camps.

* The Professor of Fortification in the Polytechnick School, did not confine himself to this general treatise. In the *oral* courses, the subjects were expanded and illustrated by numerous details and examples; and the students were compelled to construct and draw plans and estimates of fortifications adapted to *given* sites and topographical features. Such lessons were practical introductions to fortification, and tested the fitness and capacity of both pupil and professor. Doubtless this method will be observed *hereafter* in the U. S. Military Academy.

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camp according to the rules of castrametation, which are more or less modified. All that has been said in general on posts, here immediately applies; and we will only remark, that the interior redoubt should in this case be a large enclosed work, that is, a small fort (*fortin*) more or less elevated. This redoubt is begun by first tracing and marking out its outline with palisades joined together, or trunks of trees, with banquettes; and the relief is made successively of greater or less strength: the situation of this redoubt must be most carefully determined.

Second kind of intrenched camps.

The second kind of intrenched camps, are those which form part of the defensive system of a frontier. These are advantageous positions that the armies occupy and intrench, for the purpose of thence debouching to act offensively, or of holding in check an enemy's army by remaining in a defensive attitude. These camps, more or less contracted, are often placed with their back or one of their flanks resting upon a fortress, with which they form one single system. By this combination of defences, a place of moderate strength is protected, and becomes a field of battle whereon a corps d'armée may make itself formidable to an enemy's army acting on the offensive, and perhaps intending to lay siege to the place. In the general disposition of the tracé of an intrenched camp directed upon a fortress or permanent forts, the latter should project out beyond the collateral dispositions; becoming unassailable points that flank the field works, and from whence detachments may make sorties without danger of being pursued when retreating. Besides, if the enemy force the camp, the retreat is much easier, and is not subject to any of those disorders resulting from the position of a camp being in front of a fortress. An intrenched camp is not intended to cover the front of a fortress, but to extend the position or occupy some commanding height, the possession of which would secure to the enemy an easy conquest. In the last war a great many such-like dispositions were made, directly in opposition to correct principles. The camps formed in front of Dunkirk, Lille, and other places, could produce no advantages; whilst the enemy, by carrying them by assault, would increase the confidence and courage of his troops: this was actually the case before Dunkirk in 1793.

Frontier lines.

Frontier lines consist of several intrenched camps in relations of defence by their flanks; by occupying an extent of frontier, they cover it, and form its defences.

Third kind of intrenched camps.

Lastly, intrenched camps of the third kind, are those established in an enemy's country in the course of an offensive war. They are established perpendicular to the lines of operations, and serve to secure the communications to the rear, and to protect a retreat when circumstances render it necessary. Frequently these camps are fortified throughout their whole circumference; so as to be defended against any enterprising corps of the enemy that may have slipped into the rear, to cut the line of operations. These intrenched camps serve as fortresses, and are nothing less than a kind of post of great capacity; the front facing towards the enemy, deserves the most particular attention, because it is the strength of this front that is to protect the retreat.

The chief properties of intrenched camps are therefore, to place in relations all the parts of a frontier; to cover those which are too much exposed to the insults of the enemy; to occupy positions favourable for an offensive or defensive war; and to protect the retreat, and collect the wrecks of an unfortunate army.

CHAPTER IX.

The Commandment of Works; Irregular Fortification; the Art of Defilement; Caponnières used for the defence of Ditches, &c.

102. The respective commandment of works.

102. ALTHOUGH in field fortification there is seldom a necessity of using complex works of concentric forms, that must act simultaneously on the exterior ground; nevertheless there may occur occasions requiring such systems. The *interior redoubts* of which we have spoken so often, are of this class, with respect to the principal works. This peculiarity is the origin of *commandment* (*commandement*); that is, the relief of the interior works, must be greater than the relief of the principal works. The relations of commandment are easily determined, by observing that the lines of fire of the interior works, viewed in their primitive profiles, do not incommode the troops defending the advanced works. This is effected by allowing 18 to 20 decimètres (6 to 6⅔ feet) for the difference of commandment; that is, the vertical included between the horizontal planes containing the covering lines, should be about 20 decimètres. Accordingly if a work be surrounded by a glacis, its relief must raise the covering line about 20 decimètres above the crest of the glacis. The general theory of commandment shall be illustrated in the Third Part of this work.

103. Irregular fortification.

103. *Irregular field fortification*, is the application of the general principles of regular fortification to the infinite varieties of sites that nature offers to the engineer, and introducing into regular systems the modifications required by the ground. The officer whose *coup d'œil* does not seize with rapidity the properties of military sites under the relations of attack and defence, and who knows not how to adapt to their nature and form the elements of regular fortification, is not qualified for field operations; he should confine himself to the quiet and studious labours of interior works.

Causes of irregularity in fortifications.

Fortifications become irregular from two causes: 1st, by the irregularity of the site itself upon which they are laid out, and which varies the tracés and primitive profiles: 2d, by the influence that the ground in the power of the enemy possesses over

the defences; an influence that introduces further modifications of the primitive profiles and tracés.

First disposition, on acclivous ground (*a contre pente*). (See PLATE XVII, fig 1)

It is necessary to further illustrate these general ideas. The defences *B*, *C*, *D*, *E*, *F*, *G*, are established upon the left bank of a river; the line occupies the tops of the hills that skirt the valley. The tracé of this line must yield to the varieties of the ground; the salients *S*, *S*, &c. must therefore be established on the most elevated points, so that there may be a slope from the salients to the re-entering parts, &c. The detached work *R*, situated upon an important *plateau**, and occupied for the same reason, should have its capital placed upon the ridge or line of the greatest general declivity *ab*; the part *DEF* of the line that crosses a separate valley, is not drawn according to the direction of the right line *SS*, but is thrown back to form an unassailable re-entering; in order that the general branches *DE*, *EF*, consisting of parts that help to form the collateral salients *S*, *S*, may be defiled† from the plunging view of the enemy, as we will presently explain: this re-entering part may be covered by an inundation, by means of the obstruction *E*.

The profile of any part of the line. (See PLATE XVII, figs. 1 & 2)

If the tops of the hills formed a plain, the profile would be unchangeable, like those in regular fortification. But as there is a declivity from the side *E* towards the ground *A*, it follows that the enemy by taking post in an offensive attitude upon the ground at *M*, would have a plunging fire into the intrenchments. Therefore the relief of the several parts must be increased, according to the acclivity of the ground in front; the declivity being taken in the direction from *E* to *A*. Let us now suppose that the profile taken upon *cd*, is required; let *XY* be the section of the ground obtained by the process of levelling, and *MN* the vertical line containing the covering line. If the declivity be one mètre in an hundred ($3\frac{1}{3}$ feet in 333, or 1 foot in 100), the customary relief will be increased 8 to 10 decimètres ($2\frac{3}{4}$ to $3\frac{1}{3}$ feet); this will make *MN* 32 de-

* A table land.

† To *defile*, to arrannge according the art of defilement; that is, to cover or shield from the enemy's views and fires. This is effected by traverses, paradoses, epaulments, increasing the relief of the profiles, arranging the tracés, &c. &c.

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cimètres (10¾ feet), and the profile will be completed in the usual manner. It must be observed, that generally in declivities of this kind, the lines of fires, viewed in the vertical plane, are always effective; and the question resolves itself into taking in consideration the influence of the ground E over the intrenchment.

Remark upon the efficacy of the direct fires.

Let us now suppose that the defensive is maintained immediately upon the left bank of the river by the bridges P, P, &c., covered by the system of detached works L, L, &c. It is evident that the works being established upon an horizontal plane, their profiles would be unchanged but for the influence of the heights on their front, which have great command over the ground in the valley. Accordingly in this second case, the profiles are varied by the single and only cause,—the height of the ground E.

Second disposition in the plain. (Fig. 1.)

To complete the general case, let us suppose that the defences are established upon the heights on the right bank, and that we have to examine the tracé of the line O', B', C', D', &c. We must observe, that the heights upon the left bank are too distant to possess any influence over the tracé and profile; therefore the cause of irregularity in cases of this kind, is the irregularity of the very site upon which the works are laid out. We may give the line three different positions, paying attention to the form of the ground: 1st, it may be drawn upon the very declivity of the hills, if the slope be not too great, as in O'', B'', &c.: 2d, it may follow and border the crest of the hills, if the declivity of the mountains be steep and exceed 30 to 40 degrees; such is the case of the line O', B', C', D', E': 3d, Lastly, it may be thrown back in rear of the top of the hills 150 to 200 mètres (168 to 225 yards), like F', G', H', when the declivity of the hills is as great as 45° and upwards. When a separate valley V is in the way, it must not be crossed in a right line $D'F'$; but the line is thrown back, to form the re-entering $D'E'F'$, the branches of which, $D'Q'$ and $F'Q'$, making a great angle with the line of the greatest declivity, will be easily laid out in cremaillère whose separate branches will converge towards the salient summits D' and F'. It is generally in such cases very easy to make a dike I, to form an inundation that will render the re-entering part inaccessible. In the same way when we meet a gorge K, we must not cross it in a straight line, but turn it, like B', C', D'; thus forming a considerable

Third disposition upon the ground declivous from the side A to E. (Fig. 3.)

re-entering, in which wide openings may be left for columns to debouche through and attack the enemy upon the counterscarp. In this disposition, as in the first, the salients are determined according to the ground; in order that they may occupy the most favourable points for defence, and be well flanked by the re-entering parts. When it is determined to throw the line back in rear of the crest of the hills, these should be guarded by the small posts *t*, *t*, &c., lined with good marksmen who will observe the movements of the enemy. Frequently it is resolved to march out from the intrenchments upon the enemy, and charge him with the sword and bayonet at the moment that he is forming on the top of the hills, after having repulsed the sharp shooters.

The line of fire considered in its vertical plane, and its efficacy according to its angle beneath the horizontal.

The line of fire, considered in its vertical plane, makes with the horizon an angle whose boundary is determined by the direction of the slope of the parapet, and by experiment.

The efficacy of direct lines of fire, depends upon the angle under which experiment has shown that artillery and musketry fires may be executed. The more the line of fire is plunging, or beneath the horizon, the more the soldier is incommoded in firing, and the more he is obliged to uncover himself; so that the efficacy of musketry fire cannot be depended upon when the angle is more than 40 to 45 degrees below the horizontal; nor of artillery, when it exceeds 15°.

Fires, distinguished into grazing, plunging, and inefficient fires. (Fig. 4)

From this consideration of fires beneath the horizontal, it follows that they are only valuable in proportion as the declivities are not too steep. This causes them to be distinguished into *razant* or *grazing*, *plunging*, *and inefficient fires* (*feux rasans*, *et feux fichans*, *et feux nuls*). Grazing fires are those whose lines of fire form with the section of the ground *E*, an angle of 15 to 30 degrees; these are the most effective fires. Plunging fires, are when the lines of fire form with the section of the ground an angle of 30 to 45 degrees; these fires are not very destructive to an enemy, and are very inferior to those of the first kind. Lastly, the fires that are inefficient, are those that take place on very steep slopes, where the enemy cannot be seen but by mounting on top of the parapet. The 4th figure shows that the fires are *grazing* on the space *ef*; *plunging* on *f'*, and *f''*; and *inefficient* on *f'''*.

What we have just laid down upon the efficacy of plunging fires, shows that the declivities of heights have a great influence

Properties of heights or their declivities, with respect to the efficacy of fires; heights divided into 3 classes.

over the strength of the intrenchments that defend their approaches, and that they may be arranged into three classes; two of which are favourable to the use of fires, whilst the third reduces the defence to the use of the sword and bayonet.

The first class includes heights whose sides are so steep and difficult of ascent, that the enemy cannot march up them without breaking and getting into disorder; and if they can be flanked by lines drawn upon the collateral parts that project out like counter-forts, these declivities will then be destitute of direct, and be only defended by flank fires. This shows with what skill the tracé ought to be made, to take the benefit of all the advantages offered by the natural salient and re-entering parts.

Declivities of the second class, are the most common; they are but little inclined below the horizon, and form a kind of natural glacis, grazed by the lines of direct fires. These declivities are defended by both the direct and flank fires produced by the disposition of the tracé.

Declivities of the third class, are accessible, and too steep to be defended by the lines of effective fires; they are included between the two first limits. Their defence is reduced to defending the scarp with the sword and bayonet.

Formation, by profiles, of the third disposition. (Figs. 3 & 4)

The profiles of the defences now under consideration, are deduced, as in the former case, from the form of the ground E adjacent to the intrenchments. Suppose that the profile on gf is required; let $abdef$ be the line of the ground in the vertical plane; MN the perpendicular containing the vertical line drawn through P; Pa the thickness of the parapet; and ad the exterior surface of the parapet. Then from the point P draw the line of fire PT, nearly parallel or tangential to the ground; this will determine the plunge PR, in equalizing the excavation and embankment. Regard must be paid to the portion excavated behind the intrenchment, to form the terra-plain bx.

Instance of the redoubt of Veilbourg, in 1792.

Many instances have proved to military observers, that works situated on very steep heights, may be carried without almost any resistance. We witnessed a striking instance of this fact in the army of the Rhine in 1792. The vanguard, in marching upon Veilbourg, met there a corps of the advanced guard of the Prussian army, which defended the approaches in a strong redoubt upon a height. General Houchard caused the troops destined for the attack to be informed, that they could ascend

the height quietly and in order, without experiencing any resistance from the terrible fire that the enemy were about to open; and that the only resistance to be overcome, was that of the sword and bayonet. The result confirmed these assurances. The French carried the redoubt by forcing the barrier, which was ill disposed and badly defended. We might quote numerous other instances of intrenchments that have been forced in consequence of the inefficacy of the direct fires upon steep, but accessible declivities.

104. The influence of commanding heights; the art of defilement.

104. The second cause that necessarily produces great modifications in irregular fortification, deserves particular illustration, and is the origin of the *art of defilement;* but the theory of this important branch belongs to the fortification of fortresses, which will be the subject of the Third Part. We will therefore for the present merely lay down a few principles that will serve to complete the course of instruction which should be contained in this Second Part.

The reciprocal influence of heights, or of commandment in general.

Experience soon showed, that the difference between commanding heights within the effective sphere of fires, has great influence over their attack and defence; this difference is called the *commandment.* By this, one position acquires over another the property of having effective fires, against which the latter cannot contend; and has moreover the invaluable advantage of discovering all the movements of the hostile army, whilst its own are perfectly concealed.

This power of commandment, which is felt in all the operations of war, assumes, as we have already shown, a peculiar character in fortification.

Definition of defilement.

Defilement, is the laying out of the ground-plan and relief of a work in such a manner, that its interior will not be seen from any commanding point of the ground E; whilst at the same time it preserves the properties required by the rules of defence. To discover the general rules that should govern the tracé, and the means employed by descriptive geometry for constructing the primitive profiles, we will examine and estimate the influence that a commanding point possesses over a line of defence, according to their respective positions.

Influence of a commanding point over a line of defence, and the most advantageous direction that can be given to this line. (PLATE XVII, fig. 5.)

Let A be the point of departure of the line of defence ab, under the influence of the commanding point P; if now we place the line in the direction AP, it is obvious that it will be enfiladed, and that the covering line never can cover the terra-

plain *S*. If it be placed in the direction *AT*, not only the interior of the line will be seen from the commanding point, but all the troops and dispositions will be taken in reverse. But as soon as the line is thrown back upon the right on *AQ*, *AR*, *AS*, and recedes from the commanding point, the line then covers the interior. When the angle *PAS'* is only 15 to 20 degrees, the line is said to be taken obliquely (*echarpée*); these oblique fires are very annoying; but above 25 to 30 degrees, the line may be completely defiled. It is apparent that the most favourable direction for the line, is *AX*, perpendicular to *AP*; this direction is the most distant from the commanding point. It follows that the faces or branches of the works, must be elongated as far as practicable from the commanding heights.

Consequence & rule for the ground plan.

This rule likewise holds with respect to faces or branches of works, and a commanding line formed by the apparent contour of a mountain; they must tend to form the most acute angles, or be parallel with it.

Formation of the profiles by determining the rampant planes, and planes of defilement.

However well laid out a work may be that is influenced by commanding heights, it will not fulfil its destination if its relief be regulated according to the profiles of regular fortification. It is obvious, that the horizontal plane passing through the covering lines, would cut the heights; and that from all the upper parts of these, the enemy would have a plunging fire inside the works: therefore the covering line must be sufficiently raised, in order that the interior of the line (the terra-plain) shall be covered from the views of the enemy. This is effected by placing the covering line in a plane of defilement parallel to an inclined or rampant plane (*plan rampant*), which on one side passes through the boundary of the terra-plain that serves it as a hinge or axis, and on the other rests tangentially upon the surface of the commanding point; the plane of defilement is about 20 decimètres ($6\frac{3}{4}$ feet) higher than the rampant plane. When the work is enclosed and exposed to attack on all sides, the hinge of the rampant plane is placed about 300 mètres (335 yards) in rear of the works; and the covering lines are placed in a plane of defilement about 20 decimètres above the rampant plane.

First application, to part of a line with redans (Fig. 5.)

To show in what manner the rampant plane and plane of defilement are determined, let us suppose that the part *mn* of of the line of redans is to be defiled from the height *P*. Let *tq* be the boundary of the terra-plain, distant from *mn* about 20 mètres (22 yards); through *AP* draw a vertical plane that will

cut the ground in the direction *mrX*; through the point *q* let the tangent *qy* be drawn to its intersection with the ground, and the lines *tq* and *Qy* will determine the position of the rampant plane; and the direction *ZV* of a plane 20 decimètres above, will be the *plane of defilement*. The heights *fg*, *dC*, are the altitudes of the covering lines of the curtain and salient of the redan. This construction gives all that is requisite for the formation of the profiles. In general, when once the plane of defilement is known, we know also the height of the covering line at a given point of the tracé; and consequently we may draw the profile as we have done in the preceding article. The defilement therefore, in relation to the relief, consists in correctly choosing and determining the rampant plane (*plan rampant*).

Second application, to a disposition in cremaillère crossing a valley (PLATE XVII, fig. 6.)

A disposition in cremaillère, crossing a valley, requires defilement; for the branches drawn upon the slopes of the hills are exposed to a plunging fire from the opposite ground *E*; and that part of the tracé that occupies the bottom of the valley, is commanded by the mountains on the right and left. This is the principal reason for throwing back this part *CD*, and eloigning it from the commanding heights. We will now describe the defilement of the right line *CD*, and of the branch *DE*. Let *KH* be the boundary of the terra-plain of the part *CD*; from the point *D* to the salient *B*, and from the point *C* to the salient *F*, draw sight lines, and lay down the apparent contours and draw their vertical and horizontal projections *mno* and *m'n'o'*; the vertical plane of projection being taken perpendicular to *CD* or *KH*. Through the point *p*, the vertical projection of *KH*, draw the tangent *pr* to the highest part of the mountain, and we will have the direction in the vertical plane of the rampant plane; and consequently the direction *qS* of the plane of defilement. The vertical *Z'X'* will be the height of the covering line of *CD*. To defile *DE*, the same process will be observed. Draw the boundary of the terra-plain *KI*, which will be rectified upon the ground into a right line whose position is known by the tracé and by levelling: This line will be the hinge of the rampant plane. From the point *E* draw the apparent contour projected upon the horizontal plane in *tuXy*. Upon a vertical plane, of which *XY* is the direction in the horizontal plane, the direction *d* of *IK* prolonged will be sought; the curve *tuXy* will also be constructed, composed of the direc-

tions parallel to *IK* drawn through all the points of the apparent contour. These constructions being completed, through the point *d* draw a tangent to the curve *tuXy*, which shall be the direction of the rampant plane; and the point of contact *u* protracted upon the horizontal plane, will show the point of ground through which the rampant plane should pass. The three points *I*, *K*, *u*, being known by their position, the rampant plane is also known; and consequently the plane of defilement.

Third application to an enclosed work. (Fig. 7.)

Now let us suppose; 1st, that a work situated on a plane within range of commanding heights, is to be defiled; and that *D* be the point where the work is to be laid out: the height *A* being too distant to possess any power over it, attention will only be paid to the height *B*. After drawing the axis *BDX*, the work *R* will be laid out of a proper capacity, and with its faces disposed in the most advantageous manner. The rear face *D*, is here the only one that can be taken in reverse by the fires from the height *B*. At a distance of 300 mètres (335 yards) in rear of this hinder face, there will be drawn to the axis the perpendicular *KE*, which will be the hinge of the rampant plane that is to be drawn tangentially to the height *B*. Parallel to this rampant plane will be drawn the plane of defilement, 20 decimètres above it ($6\frac{3}{4}$ feet); and then we have all the necessary elements to construct the profiles and determine the relief of all the parts of the work. Notwithstanding it must be observed, that the rear face *ab* should be lowered 3 or 4 decimètres (12 to 16 inches), so that the defending troops stationed upon its banquette will not be annoyed or disturbed by the fires from the height *B*. The plane of defilement determined in this manner, will almost always, by reason of the proximity of the commanding height, give too great and often an inadmissible relief. To remedy this inconvenience, a lower rampant plane must be taken, that will diminish the relief and reduce it to the desired height. But this plane, which is more advantageous than the former, introduces defects that must be corrected. It will cut the ground in rear at *GH*; so that the enemy from the space *MN*, will see the defending troops stationed upon the banquettes of the front faces. It therefore becomes indispensable to construct upon the terra-plain a traverse perpendicular to the axis, and as near as possible to the rear, without however restraining the manœuvres for defence: this traverse will help the

(Fig. 8.)

defilement. Indeed the foot of this traverse may be taken for the hinge of the rampant plane Ty, and the plane of defilement may be made to pass 25 decimètres ($8\frac{1}{2}$ feet) above it; this will determine the relief of the front part: the direction of this plane of defilement, is ZV (fig. 8). At a height of 5 decimètres (20 inches) above the covering line of the front part, a plane will be drawn that will cut the plane of the earth at a distance of about 400 mètres (450 yards); this plane *or*, will bound the traverse T. Now as the hinder part is covered by the traverse, its relief will be regulated in such manner as is best; provided that its covering line be 5 decimètres (20 inches) below the plane VTX, passing through the summit of the traverse and 20 decimètres ($6\frac{3}{4}$ feet) above the commanding point.

2ndly, If the work were situated in D', and laid out like R'; it is plain that the left face would be taken in reverse by the height B, and the right face by the height A. In this case, besides a traverse perpendicular to the axis, another on the direction of the axis would be required.

3d, Lastly, if the work were laid out at D'', and like R''; we see that a single traverse, placed perpendicular to the axis, would cover it from being seen in reverse.

Practical methods for determining rampant planes, &c. (See *St. Paul.*)

The descriptive methods to which we have here had recourse, can be seldom followed in the arrangement of field works, which are hastily erected, and planned almost entirely by the eye. Their place is supplied by more simple and rapid methods, which engineers acquire by practice; in many circumstances the *coup d'œil* alone should suffice. Pickets, measuring lines, the circumferentor or theodolite, &c. are the instruments used for calculating upon the spot, the position of rampant planes, commanding heights, and the apparent projections of mountains or heights.

Observations upon the art of defilement applied to field works

We must observe, that the art of defilement in general requires such complex operations, and such great reliefs, that we are rarely able to apply it to field works; it is sufficient, in most cases, to defile them from musketry fires. This is effected by the selection of the site of the works, by the skill with which the tracé is arranged, and by the judicious use of interior traverses, that may be converted into redoubts made of earth or trunks of trees, &c. These truths will become more palpable after we shall have completed the descriptive part of defilement at the end of the *Third Part*.

105. Methods of increasing the strength of permanent field works.

105. By *permanent field works*, is understood that class of works whose use is not momentary, and which are constructed with more time and care ; such as the small forts (*fortins*) of intrenched camps, têtes de pont, &c. The strength of these works may be increased by means of several modern inventions, that have been used by many French and foreign engineers according to ground and circumstances. These inventions are, *defensive caponnières, interior redoubts of wood, and posterns of frame work*, made like the branches of a mine. But these species of defences can only be used when the engineer finds supplies of timber upon the very ground that he is fortifying. We have already shown the advantage of parapets made of connected palisades, and of trunks of trees well joined together by their sides, which are better still. The Austrian engineers frequently use this kind of obstacle (which will resist field artillery), either to fire over, or through loop-holes made in them.

Method of arranging trunks of trees in parapets capable of resisting artillery. (Fig. 9)

If a parapet made of trunks of trees capable of resisting artillery, be required, the trunks of trees or pieces of timber must be ranged in two rows, one behind the other and very close together. This will make a thickness of 60 centimètres (2 feet) at least, that will undoubtedly resist field artillery. To make loop-holes in this disposition, it will suffice to give alternately to the interior pieces *a*, *a*, only 140 centimètres ($4\frac{3}{4}$ feet) height, and to saw into loop-holes the exceeding portions of the pieces *b*, *b*, &c.

This is an admirable method of construction for interior redoubts, because it occupies little space, and is susceptible of greater strength than constructions in earth only.

Single defensive caponnières, used for the defence of ditches.

We have repeatedly pointed out that the greatest defects of field works are, that their ditches are destitute of fire, and of all means of defence ; and that the assailants may form in them, to come on to the assault in order and mass. To defend ditches that are not flanked, caponnières* have been invented, and established across them ; made in the manner explained, of palisades or trunks of trees. The assailed are posted behind the caponnières, and fire upon those of the enemy's troops who attempt to establish themselves in the ditches. A small ditch must be made in front of the caponnières, to prevent the enemy

* *Caponnières :* this word is derived from *capon* (French), a hypocrite. TRANSLATOR.

from reaching the loop-holes; their ground plot or floor must even be made 6 to 8 decimètres (2 to $2\frac{3}{4}$ feet) lower than the bottom of the ditch, that they may be less exposed to the effect of artillery and ricochets. *Single caponnières* can only be used when the work is so disposed, that the enemy cannot turn them and take them in reverse from the summit of the counterscarp. For example; let A be a work whose gorge is inaccessible, and the extremes of the wings of which cannot be carried by the enemy. The ditches of the faces MQ, NR, may in this case be defended by the single caponnières K, K: accordingly when the work is in the form of a redan, the whole length of the ditch is seen and scoured by the fires of the caponnières. But if the work be a polygon, or if it be assailable on its whole ambit; in the first case, the single caponnières are inadequate; and in the second, they are inadmissible; for the ditch of the face MN is not defended, and if a single caponnière were placed in it, it would be taken in rear and be of no service. In these circumstances, by making use of *double caponnières*, we obtain a similar result. But the construction of these works is more complex, and requires posterns to be established to communicate with them, which greatly increase the time and expense; the latter require more labour and skill than even the former. (Fig. 10) Double caponnieres.

Let the axis VZ be perpendicular to MN, upon which a double caponnière is to be established to produce flank fires in the ditches on the right and left. It is easy to conceive, that by placing two single caponnières on the right and left of this axis, and distant from it about 12 mètres ($13\frac{1}{3}$ yards), that they will enclose a space of 24 mètres ($26\frac{1}{2}$ yards) wide, in which the defending troops will be defiled from the counterscarps immediately opposite. But as the enemy by arriving in the direction VZ of the axis, would have a plunging fire between the two rows of palisadings or trunks of trees; this interior space between them, is covered with blinds; that is, beams are laid across it, covered over with planks or fascines; and the whole is then covered with a bed of sods or earth 20 centimètres (8 inches) thick. This work or system, is called a *double caponnière*; and is cut with loop-holes on both sides. The head S of the double caponnière, should be 15 to 18 decimètres (5 to 6 feet) distant from the counterscarp; and instead of terminating it square, it is better to form it like a salient angle that may be

defended by a disposition made in the slope of the scarp, on the right and left of the caponnière. In the same way the rear of the caponnière may be isolated from the scarp, by only commencing the blindage at a certain distance from the foot of the scarp. We however think that this disposition is vicious; because the enemy may carry by storm the palisades that unite the caponnière to the scarp, and thus cut off the retreat of the troops defending the caponnière.

The *postern* of frame work.

The *postern* of *frame work*, is a kind of gallery made of timber, leading from the terra-plain down through the parapet into the caponnière.

Instead of detaching the caponnière from the scarp, it may be more advantageous to join them, and to construct also in the form of caponnières, two returns F, F, in the scarp, which will defend the head (*museau*) S, as well as its ditch. This method is better than a simple palisading, behind which the troops might be destroyed by grenades and stones. We would observe, that the blindage should be arranged in an angular or gable form (*en forme de cape*), so that the enemy cannot sustain himself upon it, even should he succeed in mounting it to uncover part of the caponnière. Finally, the ground about the caponnière must be covered with caltrops, trous de loup, abattis, &c.

Examination of the strength of caponnieres.

Single caponnières, that the enemy cannot turn or take in flank, are an excellent defence, and must be used whenever circumstances permit. Besides the flank fires that they afford, they possess a convenient debouchè, by which to enter the ditch in force and defend it with the sword and bayonet. This may compel the enemy to bring up artillery upon the counterscarp, to batter the caponnières; this alone would be obtaining a grand advantage for the defending party. But the double caponnières, which the enemy may instantly surround, appear to us liable to be quickly forced. The soldiers marching against the caponnière, would each carry a bag of earth, and very soon fill up the little ditch that separates it from the counterscarp; and then the sappers, with axes and other implements, would cut down part of the blindage and uncover the interior of the caponnière, which would instantly fall into the power of the assailants. The separate attack of the caponnière, which the enemy is obliged to make before he can form in the ditches, is a proof that this disposition is advantageous, and that it should

be used until more effectual methods for defending the ditches are discovered*.

Reflections. (See Cessac, and Montalembert.)

The defensive dispositions that we have just described, strictly speaking, do not belong to temporary fortification; their construction requires peculiar labours and art, which class them with the fortification of fortresses. They are intermediate works, forming the chain or link between temporary fortification, and the fortification of places.

Before we further illustrate fortification, we will describe and examine a few military operations and achievements, in which temporary fortification had a distinguished and remarkable influence; in order to convince the student and young officer of the importance of this art. These examples are taken from the Military Annals of the French Monarchy, and of the last war.

* The works planned by Colonel Totten at Plattsburg, in August, 1814, were provided with caponnières, armed with howitzers, scouring the whole extent and circuit of the ditches. The tracé consisted of 3 lunettes enclosed on their whole circumference, and in relations of defence. The large centre lunette was retired from the expected front of attack, and was flanked by the two smaller collateral redoubts, which in return were flanked by it. The right redoubt rested upon the edge of the high and steep banks of the Saranac, and the left upon the precipitious bank of Lake Champlain. The line of defence from the Saranac to the lake, was about 400 yards, and the ground pretty level. The tracé much resembled that in fig. 11, Plate XIV. The Saranac emptied into the lake 1000 yards in rear; thus forming a peninsula, which could be attacked only in two directions—by crossing the bridge or fording the stream, below towards its mouth; or by crossing above, and moving down upon the front of the defensive system. The redoubts were garrisoned by about 2600 men, who would certainly have made a desperate defence if the British army, 14,000 strong, had attempted an assault. The caponnières were very strongly constituted. But these works could not have resisted a skilful cannonade, followed by a vigorous assault from such immensely superior numbers. The lunettes having been constructed in great haste, could not have resisted a heavy and continued battering. The centre lunette commanded the two others, and was the key or decisive point.

Occasions occur in field works, when the space beneath the platforms should be hollowed out and converted into a kind of interior caponnière with reverse fires, like a permanent crenated gallery. The barracks or quarters should also be arranged in relation to the interior defence; becoming a species of citadel, or defensive redoubt. Many dispositions and combinations may be made with the buildings, magazines, fougasses, &c. that will render the attack by main force most murderous, and almost hopeless.

TRANSLATOR.

CHAPTER X.

Description and Illustration of several Military Operations, under the relation of the influence of Temporary Fortification

106 General reflections upon the temporary fortifications used in battles.

106. THE works erected upon positions just before a general battle, are necessarily slightly constructed; the time allowed for their erection being frequently no more than a night or a day, or four and twenty hours at most. Accordingly the ditches of this kind of slight fortification are of small depth, and the profiles of the covering masses very imperfect and unfinished. On these occasions the engineers should multiply the auxiliary means, such as prepared hedges, war pits, abattis, chevaux-de-frise, wagons, &c. At the battle of Malplaquet, they had two days to construct the defences; at Fontenoy only one day and an half. At Neerwinden, the Prince of Orange was many days arranging his defences; and at Fleurus in 1690, the Prince of Waldeck during the two days that he occupied the position, made no defensive dispositions. At the second battle of Fleurus, in 1794, the French army had all the time that the siege of Charleroi lasted, to fortify themselves. At the battle of Montenotte, they had several days to construct the great redoubt that covered the centre. And at Millesimo, Napoleon caused several epaulments and batteries to be erected during the night, to restrain the right of the enemy's army.

Duties of the engineer officers before, and during a battle.

The arm of engineering, preceding a battle, is most actively engaged; the officers, who are generally too few in numbers, should multiply themselves by their zeal; they must lay out all the works by the *coup d'œil*, and animate the troops in their labours; sparing neither money nor pains to accomplish their objects. During the battle, these officers should station themselves in the posts, or pass along the intrenched positions, to aid with their advice the commandants of the troops charged with their defence.

Battle of Neerwinden in 1693.

We will take for the first example, the battle of Neerwinden, fought on the 29th July 1693, between the French command-

ed by embourg, and the army of the allies, under the Prince of nge.

Description of the position of Neerwinden near Tirlemont, and of the battle fought 29th July, 1693 (See the map of the frontier. & PLATE XVIII, with its explanatory table)

Strength of the French army.	Battalions 78	40,000	men.
	Squadrons 160	20,000	
	Artillery, 70 pieces		
		60,000	men.
Strength of the enemy.	Battalions 66	36,000	men.
	Squadrons 144	19,000	
	Artillery, 90 pieces		
		55,000	men.

Movements of the French upon the enemy.

Luxembourg was by nature extremely active and enterprising. Few Generals ever surpassed him in the science of marches and encampments, and in that of forming, decomposing and re-forming orders of battle. He never fought a battle without displaying some of those traits of genius that distinguish a great General, and which are decisive of victory.

The French army was encamped at the camp of Leek or Lecki, when Luxembourg heard that the enemy's army, after organizing itself under Tirlemont, had advanced and encamped upon the right bank of the little river Géete ; its right flank resting upon that river, and its left upon the brook of Landen Fermé ; the right flank of the camp formed a square, and was covered by the village of Neerwinden.

The French General immediately resolved to attack the enemy in their position ; and on the 28th at break of day, the army began its march in seven columns, two of cavalry upon each flank, and two of infantry and one of artillery in the centre. All these columns re-united, as likewise did the van guard, on the position between Pellain, St. Gertrude, and Landen Fermé. Towards night, Luxembourg with his cavalry and dragoons debouched into the plain and occupied St. Gertrude and Landen Fermé, whilst the infantry crossed the Jar and formed in columns in order of battle.

Conduct and dispositions of the enemy.

The Prince of Orange and the Elector of Bavaria, after a strong reconnaissance, did not doubt but that it was the intention of Luxembourg to attack them ; but the French army was too close upon them, to think of re-passing the Géete. The Prince of Orange resolved to fight in his position ; and in consequence made such defensive disposition as the field of battle required.

Bridges were thrown over the Géete to send the baggage to Diest. The right was posted from the Géete, opposite Elixen, to Neerwinden; the centre occupied the height from Neerwinden to the brook of Landen, in front of Neer Landen; the left was thrown back, following the course of the brook of Landen towards Dormaël. In advance of the right and beyond a little brook, was the village of Laer, which was occupied by 6 battalions of Hanoverians, supported by 3 English battalions posted behind the quick-set hedges in front of Neerwinden. The village of Neerwinden was surrounded by an intrenchment, and occupied with 6 battalions.

From Neerwinden to the height of Rumdorff, the plain was occupied by an intrenchment, part of which, towards the centre, was made of wagons. The left was covered by a ravine, behind which a parapet had been constructed.

All the cavalry were displayed in two lines in rear of the infantry; their left stretching along the brook towards Dormaël. Neer Landen was occupied by two battalions and two squadrons; six squadrons were in observation in front of Elixen and Esmaël; and 90 pieces of artillery were placed in battery along the intrenchments.

Dispositions of the French army for the attack.

The French army passed the night, between the 28th and 29th of July, posted in 11 lines on very narrow ground behind Landen and St. Gertrude. Luxembourg finding that the enemy had not stirred from their position, reconnoitred it, and determined to attack them in their intrenchments. He perceived that the villages of Laer and Neerwinden formed such great salients on the position, that it was indispensable to carry them by assault, before the right and centre could be attacked. Sixteen squadrons of dragoons passed the brook, and dismounted, and took post in front of Neer Landen, to attack the left of the enemy.

Twenty-five battalions, disposed in several lines, took post in front of Rumdorff.

Twenty-nine battalions, on the left, took post in advance of Overwinde, encompassing the villages of Laer and Neerwinden; and sustained by 3 battalions and 3 squadrons, forming a second line.

A reserve of 50 squadrons, in two lines, was to penetrate the right of the enemy as soon as the infantry had become master of the hedges.

The centre of the army was disposed in 3 lines, the second and fourth of which were infantry; these troops were to march against the intrenchments, as soon as the attacks upon the right and left would permit.

The artillery was posted against the villages of Neerwinden and Rumdorff, and against the intrenchments of the centre.

By 8 o'clock in the morning, all these dispositions were completed, and a cannonade was opened upon the villages and intrenchments.

The attack upon Laer & Neerwinden.

After the first volleys, the infantry upon the left put themselves in motion to attack Laer and Neerwinden; the enemy are driven from Laer, and the French get possession of the head of Neerwinden. The first line of the reserve of cavalry now advance and form in the plain, after driving before them part of the cavalry of the enemy's right.

But this first success did not last long; the enemy cause fresh troops, drawn from their centre, to defile through Neerwinden, which formed a continuous system with the line; these repulse the French beyond Laer. This movement compels the cavalry of the left to retire in disorder under the fire of Laer, which was re-occupied by the Hanoverians.

The second attack on the left.

Luxembourg, not at all disheartened, re-enforces his left with 12 battalions drawn from the fourth line of the centre, and orders a second attack. On the other side, the Prince of Orange draws troops from his centre, to sustain the attack on Laer and Neerwinden. Though the enemy had the great advantage of fighting upon a continuous front, the French at last succeed, after a most obstinate contest, in maintaining themselves in the last hedges of the two villages.

The attack upon the right

During these attacks on the left, the dragoons had attacked Neer Landen, from which they had partly driven the enemy, who however remained masters of the hedges. The right, which had been ordered to vigorously attack Rumdorff and the left of the enemy, made but a feeble attack, and was quickly repulsed; so that the enemy could with impunity draw troops from the left to strengthen his right.

Third general attack along the whole front.

Luxemburg perceiving the errors that had been committed on his right, repaired to that flank in person with some troops and the king's household, and determined to make a third attempt upon Laer and Neerwinden, and to cause the intrenchments in the plain to be attacked at the same time by the troops of the

right, commanded by the skilful Feuquières; believing, with good reason, that the left of the enemy had been greatly unfurnished and might be easily forced. The residue of the fourth line of the centre of 13 battalions, marched to the attack of the left. The second line, composed of the French and Swiss guards, were ordered to attack the left of the village and the intrenchment of the plain that terminated upon it. The reserve of the left was ordered to support the infantry, and to pass through all the openings.

Movements of the enemy.

The Prince of Orange seeing the brigades of infantry and the guards marching against his right, marched the greatest part of the infantry from his centre to sustain the village of Neerwinden; moreover, he caused the cavalry of his centre to change position, by throwing it back in two lines behind the infantry; its right resting near Wenges, and its left forming an angle near the middle of the intrenchment of the plain.

Feuquières perceived this false movement, and immediately made his dispositions to take advantage of it. He ordered two battalions of the right against that part of the intrenchments that was made of wagons: they experienced no resistance, and made openings for the cavalry to pass through, who placed themselves in battle array beyond the intrenchments, to take the enemy in flank.

Luxembourg learning the success of his right, put all the troops of the left in motion, who now carry both villages and advance to form in front of the enemy's cavalry. At the same moment the French and Swiss guards force the intrenchment next to the village of Neerwinden; the king's household troops endeavour to penetrate through, but are repulsed by the fire of the hostile infantry. The Prince of Orange attempts to take advantage of this disorder, and causes the Swiss troops who had not time to reform, to be charged; but Luxembourg, at the head of the French guards, repulses the enemy, and levels the intrenchments; and the household troops succeed in forming on the plain.

Formation of the cavalry in front of the enemy's right.

The enemy, rendered irresolute by the result of such impetuous attacks, and perceiving Feuquières on their left flank, leave the French infantry time to form themselves and protect the movements of the cavalry, which debouching from the right and left of the villages, form also in front of the right of the enemy, and compel them to retrograde.

As soon as the troops are formed in order of battle, the enemy is attacked in front; and the troops that had forced the intrenchment on the plain, threaten his left flank. The cavalry and other troops of his left, are separated from the centre, and compelled to retreat without fighting upon Loo and Diest. All his right and centre are thrown into the greatest disorder; a part are drowned in the Geéte, and the rest, abandoning all their artillery, retreat over the bridges on Tirlemont.

Results and losses.

The loss of the enemy was 18,000 men, including 1500 prisoners; and 60 pieces of artillery. The French loss was 8,000 men.

Reflections upon this battle.

We here see a large army beaten, notwithstanding all the efforts of artillery and engineering, by another nearly equal in strength; because, although the position of the enemy was strong in front, it had essential defects. Enclosed on its wings, it did not allow the army to act upon the flanks of the attacks; whilst the French army, free in its movements, endeavoured to penetrate at but a single point, to spread disorder and disunion into all parts. The inside of the field of battle, closed in rear by the Géete, did not afford any room for the manœuvres of the cavalry and infantry, who were continually constrained to place themselves *en potence*, and thus paralyze a portion of their strength. The bridges over the Géete not being covered with great intrenchments, the retreat was not secured; and the troops lost the confidence and hope of making a severe resistance.

Besides, the Prince of Orange had to contend with a general who was his superior in talents, and who was not to be discouraged by any difficulties, as long as his genius suggested to him the means of vanquishing. When the Prince was apprised of the march of Luxembourg, he should immediately have repassed the Géete, and only have held the right bank by a van guard and têtes de pont.

Conclusion.

These general reflections lead us to conclude, that we should know how to accurately estimate the strength of intrenchments; and that we should never consider particular *intrenched positions* as unassailable, for these are sometimes *not so strong as open positions*, on which may be combined orders of battle founded upon the valour of the troops and the science of manœuvres.

Battle of Fontenoy in 1745.

The second example that we will quote, is the battle of Fon-

Description of the intrenched position of Fontenoy. Sketch of the battle (See the map of the frontier and the plans of the position in the works of Clairac and St Paul)

tenoy, gained by the French over the combined armies, in May 1745.

The French army, commanded by Marshal de Saxe, was vigorously prosecuting the siege of the citadel of Tournai, when the General learned that the English and other allies were on the point of debouching from Ath and Mons, to raise the siege. He instantly resolved to march and meet them; leaving before Tournai, only such troops as were necessary to guard the trenches and restrain the garrison. The army, 50,000 strong, moved in three columns; the left on the road to Mons, the centre upon the road to Fontenoy, and the right upon the road to Anthoin. The head of the columns was no sooner as high as Fontenoy, about 8 kilomètres ($4\frac{1}{2}$ miles) distant from Tournai, than advice was brought, that the combined army, 60,000 strong, was only a day's march distant. The position of Fontenoy appearing to the General very favourable for giving battle upon, he determined to occupy it, and made the following dispositions.

Defensive dispositions.

The right rested upon Anthoin and upon the inundation of the Scheldt; a body of infantry occupied the village, with orders there to intrench themselves. The village of Fontenoy, 1600 mètres (1800 yards) distant from Anthoin, was occupied and fortified with the greatest care.

From Fontenoy the position was thrown back like a square, to reach the wood of Barry, 1200 mètres (1340 yards) distant from Fontenoy; the left rested upon this wood. The edge of the wood of Barry was furnished with abattis, sustained by a redoubt situated in the wood, the entrance of which was defended by another redoubt that scoured the borders of the wood and crossed its fires with the fires of the village of Fontenoy.

The front, from Anthoin to Fontenoy, was covered by three redoubts; the first, supporting the right of the village; the second, at 200 mètres (225 yards); and the third at 300 mètres (335 yards). Lastly, a battery of six 12 pounders was established upon the other side of the Scheldt, to take in flank the right of Anthoin. To provide for the case of a forced retreat, bridges were established across the Scheldt, covered by a tête de pont.

Conduct of the enemy. The battle.

It was in this position, thus prepared, and the extent of which was about 3000 mètres (3400 yards), that the battle was fought.

The enemy having made their dispositions during the night,

the two armies were in presence of each other by break of day. They began the attack by striving to force the wood of Barry, but were repulsed by the fire from the abattis and redoubts. They attempted another attack upon Anthoin ; but the six 12 pounders taking them in flank, drove them back upon their centre. The greater part of the allied army after these two unsuccessful attacks, being driven together on the centre opposite Fontenoy, naturally formed into one dreadful column, and moved slowly forward to break the centre of the French army, and cut it in two. All the cavalry of the French army repeatedly charged this immense column ; but they were constantly repulsed by the fires of artillery that it vomited forth from its centre, by performing the most skilful manœuvres.

At length the artillery at Fontenoy having succeeded in cutting lanes through this terrible column, the cavalry and infantry threw themselves into them ; and in a few minutes the disorder was complete. The enemy were cut to pieces, and pursued as far as Mons.

This simple description, is sufficient to show of what important service the arms of artillery and engineering were in this memorable battle.

The battles of Fleurus, on the 1st July 1690, and on the 27th June 1794.

Comparison between the two battles.

By drawing a parallel between these two great battles, that, with an interval of a century, were fought in the plains of Fleurus, we will place our young readers in a point of view from whence they may judge of the improvement and changes produced in grand tactics by the influence that the arms of artillery and fortification have acquired in battles in which one of the two armies is on the defensive, and occupying a position selected for fighting in.

Short description of the battle of Fleurus in 1690; Marshal Luxembourg commanding. (See the Map, & PLATE XIX.)

The campaign of 1690 was opened on the Sambre in May ; the enemy's army, commanded by the Prince of Waldeck, occupied the left bank of the Sambre with a force 40,000 strong, of which 15,000 were cavalry : they were masters of Charleroi and Namur.

The French army, under Marshal Luxembourg, was encamped a good distance from the right bank ; and by various marches and countermarches, kept the enemy in suspense. It was composed of 45,000 men, of whom 15,000 were cavalry.

Surprise of the ford of the Sambre, near Ham, by Luxembourg, 29th June, 1690.

The Prince of Waldeck was far from suspecting that the French General meditated the daring project of passing the Sambre between two fortresses; accordingly this part of the river was slightly guarded, and the defensive dispositions were badly established. The characteristic enterprise of Luxembourg was not long in displaying itself. On the 28th June, by a forced march, he arrives with a large body of cavalry in front of the ford of Ham, where the brook of Orne falls into the Sambre. The cavalry ford the river, dismount, and carry, sword in hand, the two redoubts that defended the passage. All the troops that can pass the river, take post in front of the brook and occupy the castle of Froidemont.

During these events, the enemy advances. On the 29th, he shows in front of Fleurus a large body of cavalry, who charge the French cavalry. During the 29th and 30th, several actions take place. After these two days, the armies appeared to separate. The French army encamps at Velaines; its General feigning a retreat to the right of the Sambre; his bridges are covered by the castle of Froidemont, and by the two redoubts.

During the night between the 30th June and 1st July, the enemy advances and takes post in front of Fleurus; his right resting upon Heppignies, and his left upon the village of St. Amand: his troops are excessively fatigued by being kept in motion and under arms all night.

Reflections upon the enemy's dispositions.

The right of the enemy's army was badly secured, and ought to have been covered by a few redoubts and batteries; the left was posted still worse. The village of St. Amand was not intrenched, nor even occupied; a few infantry were merely thrown into the castle. But the greatest fault was, not intrenching and guarding the whole course of the brook of St. Amand.

Their order of battle was composed of several lines; the infantry in the centre, and the cavalry on the wings. It must be observed, that at some distance from the front of the cavalry of the right there was a valley, the form of the ground of which intercepted their view.

Movements of the French army to the attack; its dispositions and manœuvres.

Luxembourg, so far from repassing the Sambre, had his army in motion by break of day to attack the enemy in his position, and was marching in several columns in order of battle. He occupies Fleurus, and from this point the first line displays be-

force the front of the enemy. Gournai, an officer of great merit, posts the cavalry of the left in the little valley in front of the enemy's right; he forms the project of outflanking their right and taking it in flank by a bold movement that the ground favoured.

Luxembourg finding the ground on the right very broken, throws some infantry into St. Amands; and perceiving that the left flank of the enemy is uncovered, conceives the project of completely turning the left of his position and attacking him in rear, whilst at the same time he causes him to be attacked in front and on the flanks. He therefore crosses the brook of St. Amands at Ligny and at the castle of Ligny, with 20 battalions and 30 squadrons; 15 of these battalions, with a numerous artillery, he displays above St. Amands; and then with the cavalry and 4 or 5 battalions reascends the brook, which he crosses at its source near the great road to Brussels. The enemy have no knowledge of this grand and brilliant movement, by which Luxembourg with part of his cavalry and a few battalions of infantry gained their rear. By meridian all the dispositions are completed, and on the given signal the army moves forward to the attack on all sides. Gournai with the left wing of cavalry, outflanks the right wing of the enemy, and overthrows them. Luxembourg forces the second line to face about (*volte face*), to make head against him. The enemy is also compelled to cover his left flank, to sustain the attack of the infantry marching out of St. Amands. Attacked on three sides, they can no longer resist; and notwithstanding a most obstinate resistance, they are broken at all points, and forced to retreat most precipitately on Charleroi and Brussels. The loss of the enemy was about 14,000 men, including 8000 prisoners, and 49 pieces of cannon. The French loss was about 4000 men, including 300 officers.

Reflections.

We see by this description, that the hostile army was totally destitute of all the resources of fortification. If they had masked the opening near the causeway (*chaussée*) to Brussels, by a redoubt or intrenchment, they would not have been turned by the cavalry; if they had fortified St. Amands, they would not have been attacked on their left flank; if they had held Fleurus by a van-guard, they would have greatly embarrassed Luxembourg; and, if they had advanced a few batteries to sweep the valley in front of their right, they would not have been taken in flank by a wing of cavalry only.

Reason for fighting the battle.

It must be confessed that Luxembourg's *coup d'œil* did wonders in this great battle; he conceived his plan at the very moment of reconnoitring St. Amand, and he executed it with the swiftness of thought. In fighting this battle, his object was to profit of the ascendancy that he possessed over the enemy's General; and to so weaken their army, as to put it out of their power to keep the field. Having become master of the country, he easily subsisted his army, which he employed in ulterior operations.

Description of the battle of Fleurus on 8th Messidor, 2d year, (27th June, 1794).

We will now place in comparison with this battle, that which was fought in our own days in the plains of Fleurus, and which constitutes an epoch in the military annals of the last war.

Situation of the armies. (See the Map of the Frontier, and PLATE XX.)

The French army having been assembled by the General in Chief on the right bank of the Sambre, its first operation was the siege of Charleroi, which was invested on the 30 Prairial of of the 2d year (1794) by 18 battalions and 2 regiments of cavalry; forming one division, which was charged with the siege.

Defensive front of the army in observation.

The army remained in observation upon the left bank, covering the siege by defensive dispositions displayed in the form of a crescent, and extending—1st, from Fontaine L'Evêque to the Piéton in front of Courcelle; 2d, from the Piéton in front of Gosselies, to Heppignies: 3d, from Heppignies to Fleurus; 4th, from Fleurus to the bend made by the Sambre at Auveloix and Tamines. The length of this semi-circular disposition exceeded 24,000 mètres (15¼ miles). The French army was 75,000 strong, of which 11,000 were cavalry*. It had 10 companies of horse artillery, manœuvring 60 pieces; which, added to 40 heavy pieces and 200 battalion guns, made a total of 300 pieces that were distributed on the several points of the defensive front.

The corps d'armée occupying defensive positions.

The head quarters, established at Marchiennes, were covered by Dories brigade, posted in advance of Fontaine l'Evêque, and by Montaigu's brigade, stationed between Trasignies and the Piéton.

Morlot's division rested upon the Piéton in front of Gosselies; its front covered by morasses, and its right secured by two redoubts. Kleber's division was posted in second line, to guard the course of the Piéton: this position was only taken in the night preceding the battle; during the siege, this divi-

* *Jomini* states the French army to have been very nearly 100,000 strong. TRANSLATOR.

sion had held post behind Fontaine l'Evêque, to cover Marchiennes. Championnet's division was stationed in advance of Heppignies, its front inclining towards Fleurus, and covered by abattis. On its centre a lunette was constructed, armed with heavy pieces.

Fleurus was covered by a redoubt, and occupied by two battalions. Lefevre's division was posted in rear of Fleurus, with its right behind Lambusart: this village was covered by two redoubts. The front of this division was covered by a continuous intrenched line. Between the divisions of Championnet and Lefevre, lay the great plain from Ransart to Fleurus, which was occupied by a reserve of cavalry of 5000 men, commanded by General Dubois. The remainder of the cavalry made part of the 8 corps or divisions, whose respective positions we have just stated.

The right of the army, from Lambusart to the bend of the river, was composed of Marceau's division of 22 battalions; it held by a detachment Boulet and Vantersée, and occupied the posts of Auveloix, Ham, Floresse, and Tamines.

Movements of the enemy to succour Charleroi.

Whilst the siege of Charleroi was pressing with vigour by Hatry's division, under the direction of the chief engineer Marescot, the combined army commanded by the Prince of Cobourg, was making preparations to succour the place. One corps d'armée advanced by Mons, Soignies and Nivelles; whilst another, commanded by General Beaulieu, advanced by Namur. This army was upwards of 100,000 strong, of whom 18,000 were cavalry; and it had a formidable artillery. Since the battle of Malplaquet, two such great armies had not been seen engaged.

On the 6th Messidor, advice was brought of the march of the enemy's columns. On the 7th, they encamped at la Chapelle-Herlaymont, near Sambref and Mazy, where they formed themselves in order of battle; their right was commanded by the Prince of Orange, the centre by the Prince of Cobourg, and the left by General Beaulieu.

Surrender of Charleroi on the 7th.

On the 7th, at six in the evening, Charleroi surrendered; its capitulation made Hatry's division disposable; and during the night it took post in second line as high up as Ransart and facing the plain of Fleurus. Every exertion was made to complete the redoubts and other intrenchments.

General Kleber was directed to detach a few battalions un-

der the Chief of Brigade Bernadotte, to occupy the posts upon the Piéton.

Attack on the French outposts.

At the very moment that Charleroi surrendered, the enemy attacked the French outposts, to make a reconnaissance and apprize the commander of that fortress of their arrival. On the 8th, at break-of-day, the general attack took place along almost the whole extent of the line.

General attack on the whole line on the 8th. at break of day.

Reconnaissances made of the enemy's march and dispositions with the balloon at Jumet.

The French made use of the balloon raised at Jumet, to observe the march and dispositions of the attacking columns. It is said that this balloon, hovering in the air, gave great uneasiness to the enemy's army.

Attack upon the left, which is forced.

The enemy made a most furious attack upon the left, defended by Montaigu's division which occupied the wood and castle of Trasignies. After a desperate resistance, this division abandoned its position, and retired; one part upon Dorie's brigade, and the other upon Marchiennes.

Three battalions, detached from Kleber's division to sustain Montaigu's, debouched out of Courcelle and prepared to charge the enemy in flank; but the retreat of Montaigu's division compelled these battalions to return.

In this posture of affairs, General Kleber received orders to cover the left of the centre of the army, by defending the right bank of the Piéton.

Progress of the enemy.

After the retreat of Montaigu's division, the enemy advanced in front of Marchiennes and established four pieces of artillery on the heights of St. Fiacre, from whence they battered the head quarters; but their main attack was against Dorie's position, whose brigade had been reinforced by part of the troops of Montaigu's division. A body of about 3,000 cavalry charged Dorie's command; but were repulsed by the fire of grape, and of the infantry, who sustained the charge with the greatest fortitude.

Movements and attack of General Kleber.

Whilst these events were passing at Fontaine L'Evêque, General Kleber crossed the Piéton and arrived with a few squadrons and battalions on the left flank of the enemy; and ranging himself in battle on the edge of the wood of Monceaux, established there a battery which taking in reverse that of the enemy, soon silenced it. At the same instant all the troops from the posts on the Piéton advanced, under the command of the Chiefs of Brigade Bernadotte and Duhêm, and attacked the

enemy in flank; this attack forced them to retire, and re-established the left in its line of battle.

Attack on the right wing, by General Beaulieu.

At the same time that the Prince of Orange was attacking the left of the army, General Beaulieu directed his attacks against the right wing. After insulting the post of Auveloix, to induce a belief that he intended to completely turn the right, he carried his principal forces against Marceaux's division, which defended Boulet and the redoubts covering Lambusart. All these posts were successively abandoned, and the attack was commenced upon the main body of the division, which, after a desperate and murderous resistance, was compelled to retrograde. Taking advantage of this movement, the enemy pushed forward 3,000 cavalry who completely routed the troops, and forced them to retire over to the right bank of the Sambre by Auveloix and Tamines. A few battalions, however, fell back upon the right of Lefevre's division; this is what the greatest part of the division should have done, but which all the efforts of the brave Marceau could not accomplish; such terror did the enemy's cavalry spread among the French infantry.

The attacks upon the centre divisions were feebly conducted; the object of the enemy being to turn the centre by the right. The success that attended Beaulieu, led the enemy to attack these; the advanced posts of Fleurus were forced, and likewise Lambusart, which covered the right of Lefevre's division. This division retired in order behind its intrenchments, and provided for the safety of its right, which Beaulieu was on the point of turning.

General Marceau having retired to the right of Lefevre's division with a few infantry, found there six battalions that Generals Lefevre and Hatry had marched to support him; with these troops he attacked the enemy in the wood of Lambusart, from which he drove them, and covered the right of the position. In the mean time the whole of Hatry's division marched by its right flank, and advanced to sustain the front attacks that the enemy were making on the intrenchments. The two divisions united, received his first attack in such a manner, as to induce him to suppose that it would be impossible to force them; nevertheless the attack was thrice renewed with great desperation, and with immense loss on both sides.

The attacks on the centre were not directed against Lambusart alone; one of the main attacks was upon Championnet's

division; this division constantly repulsed the enemy, and was supported by the reserve of cavalry that had advanced up to it. to sustain its right.

False intelligence brought to General Championnet; arrival of the General in Chief upon the spot; great combat of cavalry.

Things were in this posture when an unknown person brought the false intelligence to General Championnet, that Lambusart had been carried, and that the whole right was retreating. The General believing himself to be no longer in a situation to resist the efforts of so many united forces as would now be directed against him, made preparations to retreat. Already several pieces of artillery were withdrawn from the redoubt and the cavalry had made a retrograde movement, when the General in Chief arrived from the left with 4 battalions of Kleber's division, to support the position of Heppignies.

The General hesitated a moment on the degree of confidence to be placed in the report of a man who had disappeared; thinking that he must be a traitor, he ordered the troops to re-occupy their positions, and re-established the artillery in the redoubt. The cavalry again formed in line of battle, and charged the enemy's cavalry, who by a bold march threatened to turn the right of the position. The 4 battalions that the General had brought up, were formed in column to support the shock of the cavalry.

This charge was made with the greatest valour—the whole of the enemy's first line was overthrown, and abandoned great quantities of artillery. However, the French cavalry; formed in a single line, having neglected after the charge to immediately reform and extend their line to outflank the enemy, he profited of this error, and charging with his second line, repulsed the French cavalry and regained his artillery. He was however checked and forced to retire, by the fire of the French infantry.

Result of the battle; loss of the armies.

Disheartened by so many unsuccessful attacks, the enemy took advantage of the night to retire; leaving the field of battle in the hands of the French. Such was the issue of this great battle, whose consequences were so important. The combined army, no longer in a situation to hazard another battle, crossed the Meuse; abandoning the fortresses of Condé, Valenciennes. Quesnoy, and Landrecies, to their individual strength.

The enemy lost about 10,000 men, and 2 pieces of cannon; the French loss was estimated at 6000 men.

Reflections upon the order of battle, and defensive dispositions.

It is probable that if time had permitted, the General in Chief would have made great alterations in his order of battle;

he should have evacuated Marchiennes-au-pont, and the right bank of the Piéton, to have placed Dories' and Montaigu's divisions on its left bank in second line. It seems that Fleurus should have been more strongly intrenched; and a disposition of lunettes should have been made in the plain between Fleurus and the position of Heppignies: the cavalry would have fought with greater advantage under cover of these defences. Lastly, abattis and other means of defence were totally neglected on the right, where they would have been of the greatest service.

The few engineers, and the shortness of the time that they had to execute the works necessary on a line of such great extent, were doubtless the causes that prevented the construction of any in those parts where the natural obstacles appeared to be sufficient. In the battle of 1690, we see the army upon the defensive beaten, notwithstanding its courage; because it had neglected the resources of fortification, and other indispensable precautions. And in that of 1794, we see victory resting with the army on the defensive that made use of the protecting means afforded by fortification*.

* It is difficult to understand what influence fortification had on the issue of this battle, which like thousands, was fought *too late* and without *object* or *concert*. The dispositions of both parties, seem to have been wretched; though we find a few subordinates, such as Kleber, Lefevre, Beaulieu, and Championnet, conducting their small commands with ability. Had the Prince of Cobourg acted in *mass* against any *one* or *two* points, the French army which occupied a front of 15 miles! must have been totally destroyed. The attacks were all isolated and unconnected, and made in succession; and at the *decisive moment*, when the fate of the French army was decided, the Prince of Cobourg ordered a retreat, because he found that Charleroi had surrendered! as if the capture of the French grand army was nothing when compared with a paltry fortress. This is the 3d battle of Fleurus; a battle was fought by General Jourdan on the same ground on the 3d of June (24 days previous), in which he was beaten by Cobourg, and compelled to re-cross the Sambre, which he again passed for the fifth time and a third time bombarded Charleroi. But we will quote the words of a celebrated writer:

"The French army occupied a position in the form of a crescent, in "front of Charleroi, with its two extremities resting upon the Sambre; the "right towards Lambusart and the woods of Copiaux, and the left towards "Landely. Its whole front was covered by intrenchments.

"This circular position, sometimes necessary to cover a siege against "great forces, was dangerous in proportion to its great length; and was "as much exposed as a parallel line with a river at its back, in case the "allies made a vigorous effort in mass against one of its extremities.

"But the Prince of Cobourg thought differently: he formed his army

Battles Montenotte, Millesimo, &c. in the fourth year (1796.)

General observations.

The two campaigns of Napoleon in Italy, in 1796 and 1797, will form an epoch in history, from the extent of his conquests; and in military annals, by the methods and principles employed in effecting them, and the great improvement that they have produced in grand tactics. This important observation should not escape those who meditate on these sublime exploits—that each

" into 5 corps, subdivided for 9 attacks upon diverging radii, which be-
" longing to a circumference more elongated than Jourdan's line, were con-
" sequently more isolated and possessed less ensemble than the French di-
" visions which concentrated in proportion as they were driven in.

" This disposition was in truth two concentric semi-circles. The
" French semi-circle being of the shortest diameter, and consisting of inte-
" rior parts which could connect with each other by the chord of the arc,
" was necessarily stronger than that of the allies, which was exterior, and
" consequently of much greater extent, and whose wings could not sustain
" nor even communicate with each other, except by making the circuit of
" the circumference.

" To justify this multiplicity of columns, it was pretended, that the
" French army was to be attacked at the same time along its whole front.
" The science of war had for centuries consisted on the contrary, of know-
" ing how to engage the greatest portion of force against a single part of
" the enemy's front. Cæsar, Vegetius, Folard, and especially Frederick.
" at the battle of Leuthen, had demonstrated under the title of the ob-
" lique order, and by many other systems, how certain is the success of
" such combinations.

" How did it happen that in the first wars of the revolution, the minds
" of men were so perverted as to attempt to operate against principles. and
" to undertake to attack the whole front of the enemy, even when they
" were superior in numbers? To my mind it is evident that 80,000 men by
" attacking one half of an army of 100,000 men, and reducing the other
" half to a state of inaction, act with more wisdom than if they attacked
" the whole front, in order to fight the 100,000 men.

" The Prince of Cobourg having imbibed the gross errors that Lascy
" had promulgated, and which Mack had so unfortunately put in practice
" in the preceding campaign, resolved to attack the French army on all
" points." (*Here follows the relation of the battle.*)——" It is evident
" from this narration, that the two right divisions under Marceau, were
" forced to re-pass the Sambre; that the left under Montaigu had fled from
" the field, and the far greater part re-passed the river; and that part of
" the centre was forced to retire to new positions. It is true that Kleber's,
" Championnet's, and Lefevre's divisions still maintained their ground
" with vigour; but the columns with which they were engaged, had re-
" ceived orders to retire.

" It is probable that if the three columns of the Prince of Orange, in-
" stead of retiring upon Forchies and Anderlues, had united with Quasda-
" nowick (the 2d corps on the right) to attack Gosselies and Jumet; whilst

of these campaigns may be considered as one single and great achievement, all the events of which are so connected together, that we cannot remove a single one without destroying the beauty and relation of the whole. We regret extremely that we have not the necessary materials to describe the particulars of a few battles, under the relations of field fortification.

We would show in what manner the arm of engineering, both

" Prince Kaunitz, the Archduke Charles, and Beaulieu (the 3d, 4th, and " 5th corps to the left) had united against Fleurus; the allies must have " been victorious. But the Prince of Cobourg who could sacrifice 10,000 " men to save a paltry town, never knew how to risk a battalion to at- " tempt a grand stroke against an army. Charleroi being taken, he thought " that he ought to retire; and he gave orders to retreat at the very mo- " ment when a simultaneous effort of his corps, would have gained him " the victory and Charleroi too, for this place was no longer tenable.

" Notwithstanding all the incoherence of the attacks, we see from the " posture which affairs were in between 3 and 4 o'clock (P. M.), that the " French were about to be forced to re-pass the Sambre. And we may " judge what would have happened, if, instead of beginning the battle by " isolated columns, the allies had concentrated their efforts. By resting " their right under the Prince of Orange on the Piéton towards Thumeon " and Gosselies, their centre on Wagné and Fleurus, and their left upon " Lambusart (this line would not exceed 3 leagues, and would soon have " been shortened to 2), they would not have had to fight the French left, " and they would in any event have saved their communications by Lou- " vain and Tirlemont; whilst by carrying their blows against the French " left, towards Trassegnies and Fontaine L'Evêque, they might loose all " their communications.

" General Jourdan must have been most happy to find the enemy re- " treating at the moment that the victory was *at least* undecided. He " caused Kaunitz's column, which covered the retreat, to be pursued by " General Dubois with the reserve of cavalry. A charge was made near " St. Fiacre; the Austrian Hussars were warmly pressed, and their in- " fantry formed the square. But the Prince of Lambèse having advanced " with the carabiniers, overawed the French squadrons and checked them. " It has been said that this charge decided the victory; but it was not so. " The whole army was already in retreat pursuant to order, when this " charge was attempted; it had no other result than some slaughter. The " prisoners were few; some cannon were taken by the light cavalry and " second line; but were re-taken. The loss on each side may be estimat- " at 4 to 5,000 men *hors de combat.*

" The French army remained in its intrenched positions. The Prince " of Cobourg retired upon Nivelles."—*See Jomini, Part II, vol. 6.*

Many of the details given by Jomini, essentially differ from the above description; but the whole was so replete with blunders, that it is not worth entering into details when we know the general vices and defects of the dispositions. The retreat of the Prince of Orange was most unlucky.

TRANSLATOR.

on the side of the French and on that of the enemy, was at each instant combined with the other arms, to modify their effects. By describing the works of all kinds constructed upon the different positions, we would show the use and value of fortification, and its influence in the favourable and unfavourable circumstances in which the belligerent armies found themselves each day. But what should console us for the want of these details, is the hope of one day seeing the description of those memorable events presented for the instruction of young officers and meditation of all military men, by the General who directs the labours of the *dêpot de la guerre.* This inestimable work will be distinguished above all others of the kind that exist, by the accuracy of the facts and the clearness and correctness of the topography.

In both these campaigns, the French General had too few cavalry; and his operations were in a country too much broken and diversified, to rest upon this arm his hopes of success. Like all the Generals of antiquity, he was convinced that infantry is the soul of armies; and by the manner in which he supported, seconded, and protected his infantry, he arrived at those dazzling results, which are both subjects of admiration and instruction; and which prove that an able General may expect to conquer, when he knows how to combine all the elements of force under his command, and to give to them all the impulse and celerity of which they are susceptible.

Battle of Montenotte, 12th April 1796 (See the General Map of Italy)

We have already stated (art. 57) in what manner the army of Italy had been suddenly roused from inaction by Napoleon; his first movements were the preludes of the battle of Montenotte. Let us consider that part of this general action, which relates to fortification. Before the 18th Germinal, a great redoubt was constructed on an advantageous position that covered the centre of the army. The enemy had formed the project of penetrating at this point; conceiving it possible to cut the French army in two. The French General ordered 1500 grenadiers to defend the redoubt, and to hold in check the great forces that General Beaulieu had brought forward. A most desperate and glorious defence afforded time to a division to arrive in rear of the redoubt, to support it and check the enemy. Whilst a battle without any great object was thus fighting in the centre, the French General, by rapid and admirably combined movements, turned the right of the hostile army, put it to rout, and gained a complete victory.

Observations upon the redoubt of Montenotte.

The redoubt of Montenotte, which contained some artillery and two battalions, was probably not a simple redoubt with unflanked ditches; it is probable that it was a small fort, with flank fires and defences in the ditches. The complete description of this battle will establish these instructing details.

Result of the battle.

After the battle of Montenotte, the army crossed from the dividing slopes (*versans*) of the Mediterranean Sea, to those of the ocean; passed the summit of the Alps, and assumed the offensive. We behold this army, which a short time before was broken and dispirited, acquire the greatest confidence in its General and in its own strength, and march from victory to victory! So powerful is the empire of genius.

Battle of Millesimo, 25th Germinal.

The army made several movements after the battle of Montenotte, which led to the battle of Millesimo. Let us pause a moment to contemplate a special operation, connected with the use of fortification. On the 24th, General Provera was enveloped in his position at Cassaria, by several French corps. Being summoned to surrender, he refused, and retired into the castle of Cassaria with 1500 grenadiers. The slight fortifications of this castle were made such good use of, that the enemy maintained himself in it during the whole day, and repulsed the attacks of 3 French columns.

The enemy's General intended under cover of night, to cut his way sword in hand through the French troops. But General Bonaparte in this instance showed himself both an able General, and a good artillerist and engineer. He caused the enemy to be invested by a cordon of battalions distant 150 mètres (163 yards) from the intrenchments, and epaulments made of large casks to be constructed and armed with howitzers, &c. By these novel dispositions, the idea of which was derived from the theory of the attack of fortresses, he deprived General Provera of all hopes of cutting his way through the French forces.

On the 25th at break of day, the armies found themselves in presence of each other; the left of the French still enveloping and cannonading the castle Cassaria, which surrendered at discretion at the moment that the General was carrying the greater part of his forces to the right, to attack the intrenched village of Dego. What combats must be fought before these intrenchments are forced! The village is turned, attacked, and carried after several charges with the bayonet. This splendid victory made the French General master of the position of Millesimo.

Second battle of Dego.

The village of Dego was of such great importance to either army, that General Beaulieu caused it to be attacked on the 26t by the elite of his army, and succeeded in driving the Frenc from it. In the course of the same day Napoleon directed fresh attacks upon the batteries and intrenchments that covered the position of Dego. Several times the columns were repulsed but at last, after many movements and combined attacks, the enemy are compelled to retire in disorder, and with great loss

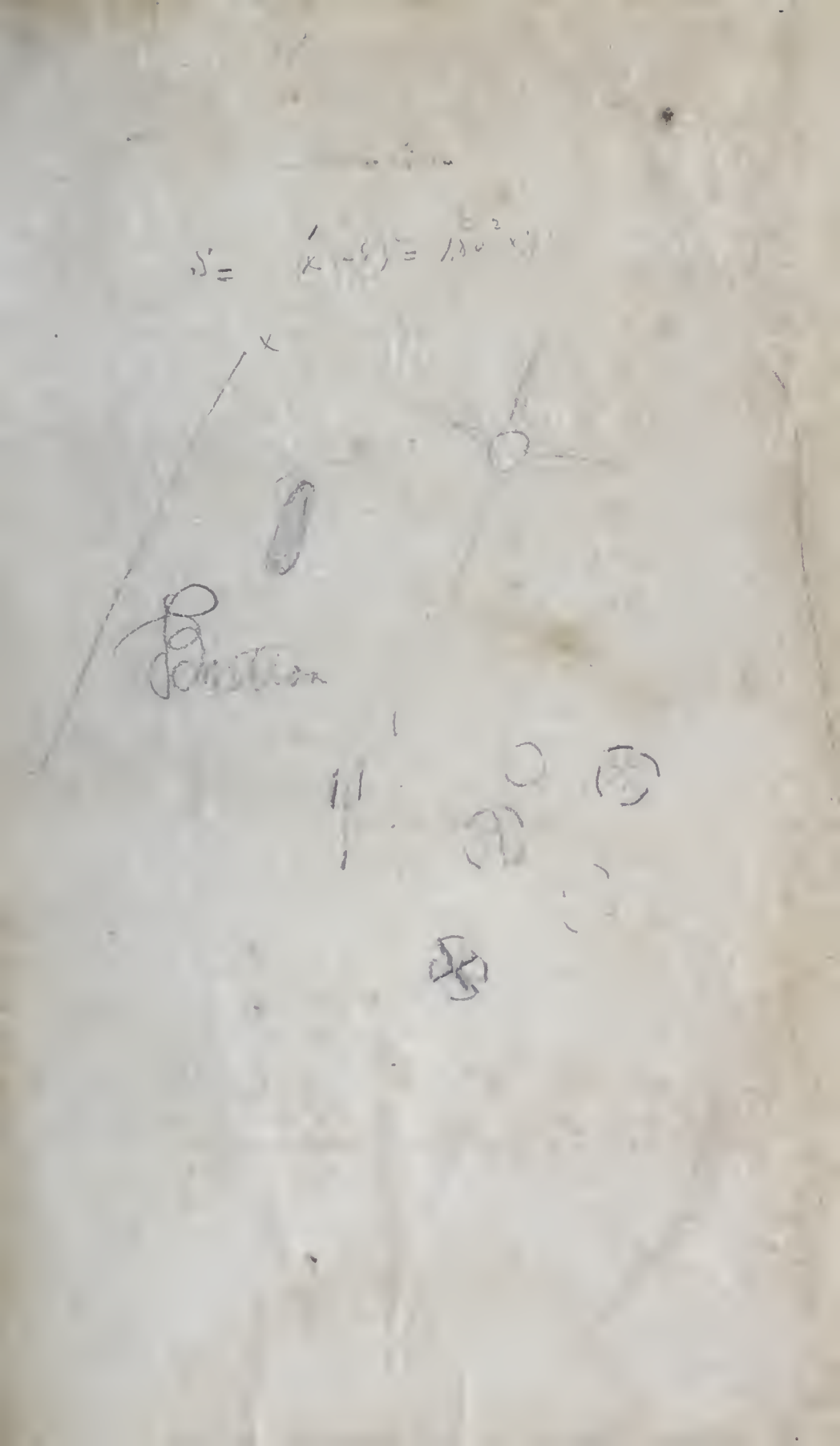
Result of the preceding battles.

The victories of Millesimo and Dego obtained for the Frencl General great advantages; he gained possession of large magazines of provisions and munitions of war, which happily afforded him the means of giving the enemy no respite. He ha weakened their army by 12,000 men and 40 pieces of cannon He had separated the combined armies, and was upon the ev of forming a junction with the division that had already occupied the valley of the Tanaro.

Conclusion.

If we were to follow the marches and ulterior operations of this army, every where victorious, we would see it attacking and forcing the redoubts of Montezemo, the intrenched camp of Ceva, and investing and capturing the citadel of Ceva, &c. We would behold the hostile army covering the centre of its position at Mondovi, with a formidable redoubt; this redoubt carried at the point of the bayonet, and the taking of it become the cause of gaining the battle of Mondovi. But these relations, so much the more instructing to the young officer, as they are of a nature to captivate his attention and please his imagination, would lead us far from our subject. We only purposed to examine the form and properties of fortifications, and the advantages of their use. We will therefore content ourselves with observing, that by following the two belligerent armies, we would behold the whole extent of the line of operations from Montenotte to Mantua, covered with intrenched camps, redoubts, posts, têtes de pont, and fortresses, &c. Whence we should conclude, that in the present mode of warfare, the arm of engineering is ever active and fruitful in defensive resources, and has an influence that increases in proportion as the science of war tends to perfection and is carried on upon a grand scale; and that the study of field fortification should be an essential part of the education of young officers of all arms.

END OF THE SECOND PART,
AND OF THE FIRST VOLUME.



Kings Lynn

